

Chapter 12

North Central Forest Ecological Landscape



Where to Find the Publication

The Ecological Landscapes of Wisconsin publication is available online, in CD format, and in limited quantities as a hard copy. Individual chapters are available for download in PDF format through the Wisconsin DNR website (<http://dnr.wi.gov/>, keyword “landscapes”). The introductory chapters (Part 1) and supporting materials (Part 3) should be downloaded along with individual ecological landscape chapters in Part 2 to aid in understanding and using the ecological landscape chapters. In addition to containing the full chapter of each ecological landscape, the website highlights key information such as the ecological landscape at a glance, Species of Greatest Conservation Need, natural community management opportunities, general management opportunities, and ecological landscape and Landtype Association maps (Appendix K of each ecological landscape chapter). These web pages are meant to be dynamic and were designed to work in close association with materials from the Wisconsin Wildlife Action Plan as well as with information on Wisconsin’s natural communities from the Wisconsin Natural Heritage Inventory Program.

If you have a need for a CD or paper copy of this book, you may request one from Dreux Watermolen, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707.



Photos (L to R): Blackburnian Warbler, photo by Brian Collins; Spruce Grouse, photo by Ray White; fairy slipper, photo by Thomas Meyer, Wisconsin DNR; American marten, photo by Erwin and Peggy Bauer; Black-throated Blue Warbler, photo by Steve Maslowski.

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Cover Photos

Top left: Old-growth hemlock-hardwood forest with supercanopy eastern white pine borders the East Branch of the Presque Isle River. Winegar Moraine, Vilas County. Photo by Eric Epstein, Wisconsin DNR.

Bottom left: Poor fen, black spruce swamp, seepage pond, and headwaters stream are surrounded by extensive forest, including patches of old-growth hemlock. Alvin Creek Headwaters, Chequamegon-Nicolet National Forest, Forest County. Photo by Eric Epstein, Wisconsin DNR.

Top right: Black-throated Blue Warblers (Wisconsin Special Concern) nest close to the ground in thickets of shrubs or saplings within large patches of older mesic forest in northern Wisconsin. Photo by Steve Maslowski.

Center right: This complex and extensive wetland at the edge of the Winegar Moraine includes northern white-cedar swamp, hardwood swamp, northern sedge meadow, several ponds, and a headwaters stream. Vilas-Iron counties. Photo by Eric Epstein, Wisconsin DNR.

Bottom right: Ephemeral pond on poorly drained ground moraine. These are common features in some parts of the North Central Forest. Photo by Carmen Wagner.



Jason Hollinger

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North Central Forest Ecological Landscape at a Glance

Physical and Biotic Environment

Size

This ecological landscape encompasses 9,543 square miles (6,107,516 acres), representing 17% of the area of the state of Wisconsin.

Climate

Typical of northern Wisconsin, the mean growing season in the North Central Forest is 115 days, the shortest growing season of all ecological landscapes. The mean annual temperature is 40.3°F. Summer temperatures can be cold or freezing at night in low-lying areas, limiting the occurrence of some biota. The mean annual precipitation is 32.3 inches, and the mean annual snowfall is 63 inches. However, heavier snowfall can occur closer to Lake Superior, especially in the northwestern part of the ecological landscape in the topographically higher Penokee-Gogebic Iron Range. The cool temperatures and short growing season are not conducive to supporting agricultural row crops, such as corn, in most parts of the ecological landscape. Only 6% of the North Central Forest is in agricultural use. The climate is especially favorable for the growth of forests.

Bedrock

The North Central Forest Ecological Landscape is predominantly underlain by igneous and metamorphic rock, generally covered by 5 to 100 feet of glacial drift deposits.

Geology and Landforms

Landforms are characterized by end and ground moraines with some pitted outwash and bedrock-controlled areas. Kettle depressions are widespread and steep; bedrock-controlled ridges are found in the northern portion of the North Central Forest. Two topographically prominent areas in the North Central Forest are the Penokee-Gogebic Iron Range in the north (which extends into Upper Michigan), and Timm's Hill, the highest point in Wisconsin (at 1,951 feet) in the south. Drumlins are important landforms in some parts of the North Central Forest.

Soils

Soils consist of sandy loams, sands, and silts. Organic soils (peats and mucks) are common in poorly drained lowlands.

Hydrology

Rivers, streams, and springs are found throughout this ecological landscape. Major rivers include the Wisconsin, Chippewa, Flambeau, Jump, Wolf, Peshtigo, Pine, and Popple. Large lakes include Namekagon, Lac Courte Oreilles, Owen, Round, Butternut, North Twin, Metonga, Pelican, Pine, Kentucky, Pickerel, and Lucerne. Several large man-made flowages occur in the North Central Forest, including the Chippewa, Turtle-Flambeau, Gile, Pine, and Mondeaux. There are several localized but significant concentrations of glacial kettle lakes associated with end and recessional moraines (e.g., the Perkinstown, Bloomer, Winegar, Birchwood Lakes, and Valhalla/Marenisco moraines). In southern Ashland and Bayfield counties, the concentrations of lakes are associated with till plains or outwash over till. Lakes here are due to dense till holding up the water table. Rare lake types include marl and meromictic lakes and ultra-oligotrophic, deep seepage lakes.

Current Land Cover

Forests cover approximately 75% of the North Central Forest. The mesic northern hardwood forest is dominant, made up of sugar maple, basswood, and red maple, with some stands containing scattered hemlock, yellow birch, and/or eastern white pine pockets. The aspen-birch forest type group is also abundant, followed by spruce-fir (most of the "spruce-fir" here is lowland conifer forests on acid peat—not upland "boreal" forest). Forested and nonforested wetland communities are common and widespread. These include Northern Wet-mesic Forest (dominated by either northern white-cedar or black ash), Northern Wet Forest (acid conifer swamps dominated by black spruce and/or tamarack), and nonforested acid peatlands (bogs, fens, and muskegs). Other relatively common wetland communities here are alder thicket, sedge meadow, and marsh (including wild rice marsh).

■ Socioeconomic Conditions

The counties included in this socioeconomic region are Bayfield, Washburn, Rusk, Sawyer, Chippewa, Iron, Ashland, Price, Taylor, Lincoln, Langlade, Forest, and Florence.

Population

The population was 244,020 in 2010, 4.3% of the state total.

Population Density

19 persons per square mile

Per Capita Income

\$26,738

Important Economic Sectors

The largest employment sectors in 2007 were Government (15.3%), Tourism-related (11.1%), Manufacturing (non-wood) (10.5%), and Retail Trade (10.0%), reflecting high government and tourism-related dependence. Although forestry does not have a large impact on the number of jobs it produces, it is the sector that has the largest impact on the natural resources in the ecological landscape.

Public Ownership

Forty-two percent of the North Central Forest Ecological Landscape is publicly owned, mostly by federal, state, or county governments. Federal ownership includes the Chequamegon-Nicolet National Forest. State ownership includes the 90,000-acre Flambeau River State Forest and several other large properties, including the Kimberly-Clark Wildlife Area. Counties in or partially within the North Central Forest and with large county forests include Ashland, Bayfield, Chippewa, Florence, Forest, Iron, Langlade, Lincoln, Oneida, Price, Rusk, Sawyer, Taylor, and Washburn counties. A map showing public land ownership (county, state, and federal) and private lands enrolled in the forest tax programs in this ecological landscape can be found in Appendix 12.K at the end of this chapter.

Other Notable Ownerships

The Wisconsin Chapter of The Nature Conservancy has several major projects in the North Central Forest, in northern Vilas County, and at Catherine Lake in Ashland-Iron counties. The Nature Conservancy has also partnered with the Wisconsin DNR, the U.S. Forest Service, and various private groups on various research, land use planning, and protection projects, including one in the Pine-Popple Watershed (in part to remedy poorly sited or constructed stream crossings or culverts that act as barriers to the movement of aquatic life) in the eastern part of the ecological landscape. American Indian lands include the Lac Courte Oreilles, Lac du Flambeau, and Potawatomi reservations.

■ Considerations for Planning and Management

One of the major planning and management considerations in the North Central Forest is clarification of the roles played by and ecological relationships among public, private, industrial, and tribal lands from conservation, socioeconomic, and recreational perspectives. In recent years, there has been documentation of widespread negative impacts to Wisconsin forests from excessive white-tailed deer browse; nonnative earthworms, insects, plants and pathogens; divestitures of large private holdings (especially estates and industrial forests); increased parcelization; and the development of shoreline habitats. Other important factors to consider include the potential implications of climate change, ecological impacts of increased biomass harvest, forest type conversions, forest simplification and homogenization, and the need to develop ecologically appropriate and economically viable restoration methods for mesic forests.

■ Management Opportunities

The North Central Forest Ecological Landscape contains the best large-scale interior forest management opportunities in the state. There are opportunities to create or maintain large habitat patches, develop or reestablish greater connectivity between forest habitat patches, and restore missing and diminished cover types. Restoring conifers in now simplified, hardwood-dominated forests is a major opportunity on some ownerships. Hemlock and yellow birch, once the dominant tree species in this ecological landscape, are now greatly reduced and declining. Both species, and several others, are difficult to regenerate, so developing effective regeneration methods, given high levels of white-tailed deer herbivory, is a management need.

Old forests are a rare and declining resource in Wisconsin. The North Central Forest offers excellent opportunities to manage areas for older forest within a context of outstanding aquatic features, intact and relatively undisturbed wetlands, and vast forested public landholdings. Working forests could include areas with extended rotations, areas within which the development of old-growth forest characteristics are encouraged, and/or stands of “managed old-growth.”

Wetlands are abundant here and include forested, shrub, and herbaceous types. Collectively, wet-mesic forests, including northern white-cedar-dominated Northern Wet-mesic Forest and black ash-dominated Hardwood Swamp, are more common here than anywhere else in the state. Acid peatland communities are common and widespread. Ephemeral ponds are abundant and provide important habitat for numerous animals, some of them habitat specialists. Protecting the hydrology and overall integrity of the North Central Forest’s wetlands is a major opportunity.



Old-growth supercanopy eastern white pine over hemlock-hardwood forest on undeveloped lakeshore. Vilas County. Photo by Eric Epstein, Wisconsin DNR.

Aquatic resources are in generally good condition compared to many areas elsewhere in the state. Water quality is high, sediment and pollutant loads are low, flow levels tend to follow normal patterns on many streams, and the diversity of aquatic organisms is significant. Maintaining the high percentage of forest cover existing within the North Central Forest's watersheds is, arguably, the most critical factor in maintaining high water quality and supporting all of the aquatic species native to and dependent on northern Wisconsin's lakes and streams.

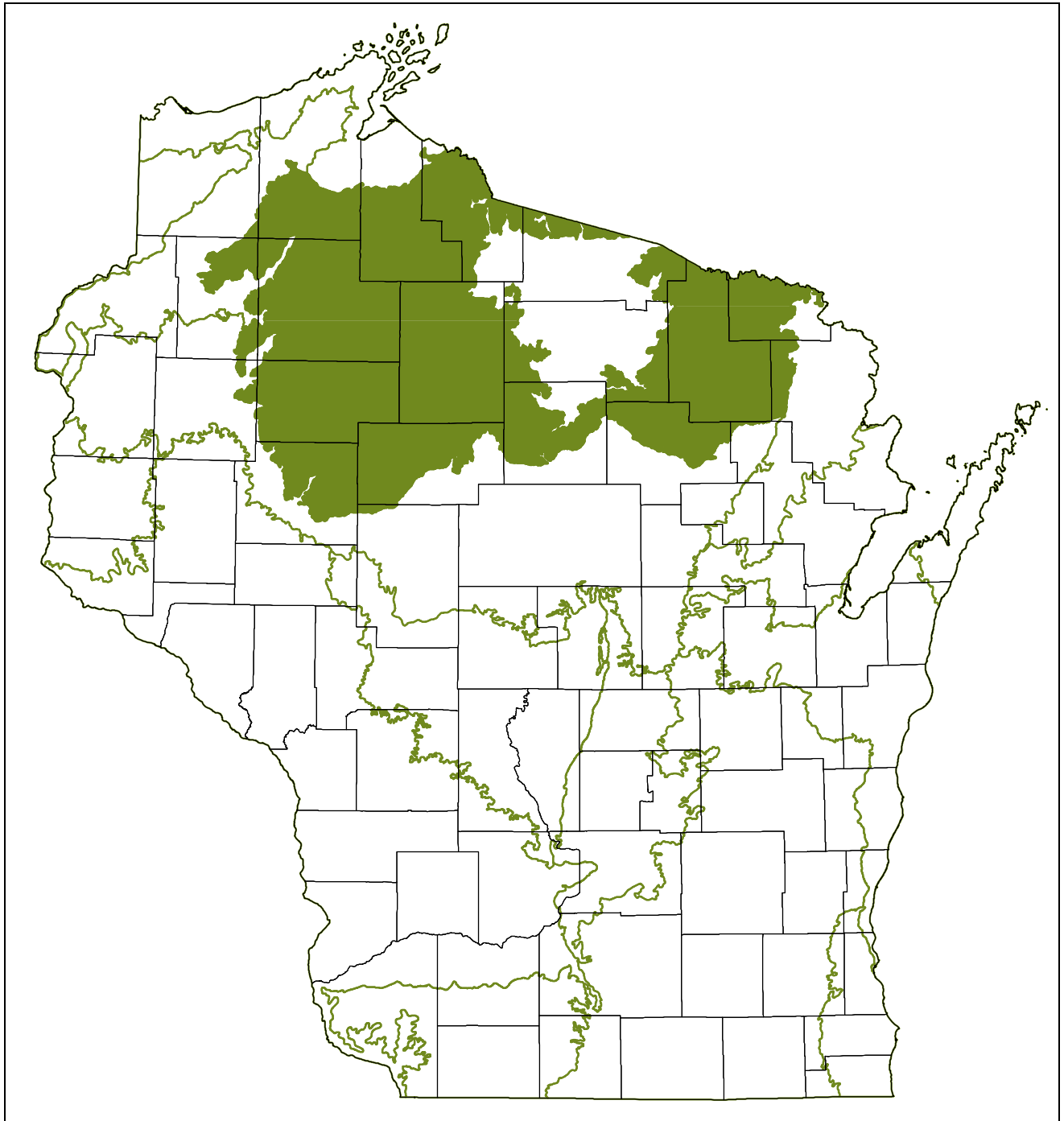
Invasive species are, generally, less abundant here than in many other ecological landscapes, especially those in the southern half of the state. However, invasive species detections are increasing here. Controlling these species before they become abundant (which has already happened in other



This diverse, structurally complex stand of older northern mesic forest is composed of eastern hemlock, yellow birch, sugar maple, northern white-cedar, and eastern white pine, among others. Ashland County. Photo by Eric Epstein, Wisconsin DNR.

parts of the state) is an important management consideration because both control efforts and costs are more manageable while problems are still localized.

There are good opportunities to maintain communities and habitats that are either especially well represented here or rare elsewhere in the state. In addition to the vast mesic forests that comprise the matrix vegetation of this ecological landscape, there are also lowland forests dominated by either northern white-cedar or black ash, acid peatlands, bedrock glades, and moist cliffs. Through integrated planning efforts and the development of cost effective and viable restoration techniques, it should be possible to provide for the needs of the vast majority of plants and animals native to the North Central Forest, including the many rare species that have been documented here.



North Central Forest Ecological Landscape



North Central Forest Ecological Landscape

Introduction

This is one of 23 chapters that make up the Wisconsin DNR's publication *The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management*. This book was developed by the Wisconsin DNR's Ecosystem Management Planning Team and identifies the best areas of the state to manage for natural communities, key habitats, aquatic features, native plants, and native animals from an ecological perspective. It also identifies and prioritizes Wisconsin's most ecologically important resources from a global perspective. In addition, the book highlights socioeconomic activities that are compatible with sustaining important ecological features in each of Wisconsin's 16 ecological landscapes.

The book is divided into three parts. Part 1, "Introductory Material," includes seven chapters describing the basic principles of ecosystem and landscape-scale management and how to use them in land and water management planning; statewide assessments of seven major natural community groups in the state; a comparison of the ecological and socioeconomic characteristics among the ecological landscapes; a discussion of the changes and trends in Wisconsin ecosystems over time; identification of major current and emerging issues; and identification of the most significant ecological opportunities and the best places to manage important natural resources in the state. Part 1 also contains a chapter describing the natural communities, aquatic features, and selected habitats of Wisconsin. Part 2, "Ecological Landscape Analyses," of which this chapter is part, provides a detailed assessment of the ecological and socioeconomic conditions for each of the 16 individual ecological landscapes. These chapters identify important considerations when planning management actions in a given ecological landscape and suggest management opportunities that are compatible with the ecology of the ecological landscape. Part 3, "Supporting Materials," includes appendices, a glossary, literature cited, recommended readings, and acknowledgments that apply to the entire book.

This publication is meant as a tool for applying the principles of ecosystem management (see Chapter 1, "Principles of Ecosystem and Landscape-scale Management"). We hope it will help users better understand the ecology of the different regions of the state and help identify management that will sustain all of Wisconsin's species and natural communities while meeting the expectations, needs, and desires of our public and private partners. The book should provide valuable tools for planning at different *scales*, including master planning for Wisconsin DNR-managed lands, as well as assist in project selection and prioritization.

Many sources of data were used to assess the ecological and socioeconomic conditions within each ecological landscape. Appendix C, "Data Sources Used in the Book" (in Part 3, "Supporting Materials"), describes the methodologies used as well as the relative strengths and limitations of each data source for our analyses. Information is summarized by ecological landscape except for socioeconomic data. Most economic and demographic data are available only on a political unit basis, generally with counties as the smallest unit, so socioeconomic information is presented using county aggregations that approximate ecological landscapes unless specifically noted otherwise.

Rare, declining, or vulnerable species and natural community types are often highlighted in these chapters and are given particular attention when Wisconsin does or could contribute significantly to maintaining their regional or global abundance. These species are often associated with relatively intact natural communities and aquatic features, but they are sometimes associated with cultural features such as old fields, abandoned mines, or dredge spoil islands. Ecological landscapes where these species or community types are either most abundant or where they might be most successfully restored are noted. In some cases, specific sites or properties within an ecological landscape are also identified.

Although rare species are often discussed throughout the book, "keeping common species common" is also an important

Terms highlighted in green are found in the glossary in Part 3 of the book, "Supporting Materials." Naming conventions are described in Part 1 in the Introduction to the book. Data used and limitation of the data can be found in Appendix C, "Data Sources Used in the Book," in Part 3.

consideration for land and water managers, especially when Wisconsin supports a large proportion of a species' regional or global population or if a species is socially important. Our hope is that this publication will assist with the regional, state-wide, and landscape-level management planning needed to ensure that most, if not all, native species, important habitats, and community types will be sustained over time.

Consideration of different scales is an important part of ecosystem management. The 16 ecological landscape chapters present management opportunities within a context of ecological functions, natural community types, specific habitats, important ecological processes, localized environmental settings, or even specific populations. We encourage managers and planners to include these along with broader landscape-scale considerations to help ensure that all natural community types, *critical habitats*, and aquatic features, as well as the fauna and flora that use and depend upon them, are sustained collectively across the state, region, and globe. (See Chapter 1, "Principles of Ecosystem and Landscape-scale Management," for more information.)

Locations are important to consider since it is not possible to manage for all species or community types within any given ecological landscape. Some ecological landscapes are better suited to manage for particular community types and groups of species than others or may afford management opportunities that cannot be effectively replicated elsewhere. This publication presents management opportunities for all 16 ecological landscapes that are, collectively, designed to sustain as many species and community types as possible within the state, with an emphasis on those especially well represented in Wisconsin.

This document provides useful information for making management and planning decisions from a landscape-scale and long-term perspective. In addition, it offers suggestions for choosing which resources might be especially appropriate to maintain, emphasize, or restore within each ecological landscape. The next step is to use this information to develop landscape-scale plans for areas of the state (e.g., ecological landscapes) using a statewide and regional perspective that can be implemented by field resource managers and others. These landscape-scale plans could be developed by Wisconsin DNR staff in cooperation with other agencies and non-governmental organizations (NGOs) that share common management goals. Chapter 1, "Principles of Ecosystem and Landscape-scale Management," in Part 1 of the book contains a section entitled "Property-level Approach to Ecosystem Management" that suggests how to apply this information to an individual property.

How to Use This Chapter

The organization of ecological landscape chapters is designed to allow readers quick access to specific topics. You will find some information repeated in more than one section, since our intent is for each section to stand alone, allowing the

reader to quickly find information without having to read the chapter from cover to cover. The text is divided into the following major sections, each with numerous subsections:

- Environment and Ecology
- Management Opportunities for Important Ecological Features
- Socioeconomic Characteristics

The "Environment and Ecology" and "Socioeconomic Characteristics" sections describe the past and present resources found in the ecological landscape and how they have been used. The "Management Opportunities for Important Ecological Features" section emphasizes the ecological significance of features occurring in the ecological landscape from local, regional, and global perspectives as well as management opportunities, needs, and actions to ensure that these resources are enhanced or sustained. A statewide treatment of integrated ecological and socioeconomic opportunities can be found in Chapter 6, "Wisconsin's Ecological Features and Opportunities for Management."

Summary sections provide quick access to important information for select topics. "North Central Forest Ecological Landscape at a Glance" provides important statistics about and characteristics of the ecological landscape as well as management opportunities and considerations for planning or managing resources. "General Description and Overview" gives a brief narrative summary of the resources in an ecological landscape. Detailed discussions for each of these topics follow in the text. Boxed text provides quick access to important information for certain topics ("Significant Flora," "Significant Fauna," and "Management Opportunities").

Coordination with Other Land and Water Management Plans

Coordinating objectives from different plans and consolidating monetary and human resources from different programs, where appropriate and feasible, should provide the most efficient, informed, and effective management in each ecological landscape. Several land and water management plans dovetail well with *The Ecological Landscapes of Wisconsin*, including the Wisconsin Wildlife Action Plan; the Fish, Wildlife, and Habitat Management Plan; the Wisconsin Bird Conservation Initiative's (WBCI) All-Bird Conservation Plan and Important Bird Areas program; and the *Wisconsin Land Legacy Report*. Each of these plans addresses natural resources and provides management objectives using ecological landscapes as a framework. Wisconsin DNR *basin* plans focus on the aquatic resources of water basins and watersheds but also include land management recommendations referencing ecological landscapes. Each of these plans was prepared for different reasons and has a unique focus, but they overlap in many areas. The ecological management opportunities provided in this book are consistent with the objectives provided in many

of these plans. A more thorough discussion of coordinating land and water management plans is provided in Chapter 1, “Principles of Ecosystem and Landscape-scale Management,” in Part 1 of the book.

General Description and Overview

The North Central Forest Ecological Landscape occupies much of the northern third of Wisconsin. Its landforms are characterized by end and ground moraines with some *pitted outwash* and bedrock controlled areas. Kettle depressions and steep ridges are found in the northern portion. Two prominent areas in this ecological landscape are the Penokee-Gogebic Iron Range in the northern part of the ecological landscape, extending into Upper Michigan, and Timm’s Hill, the highest point in Wisconsin (1,951 feet), in the southern part of the ecological landscape. Soils consist of sandy loam, sand, and silts. Forests here are extensive, and this ecological landscape contains over 28% of the state’s forests. Both forested and unforested wetlands are numerous. Agriculture is much less prevalent here than in much of the state, partially due to a climate that is generally not well suited to crop production. Lake Superior influences climate in the northern portion of the North Central Forest, especially during the winter season when greater snowfall occurs here than in most areas in Wisconsin.

The *historical vegetation* here was primarily mesic hemlock-hardwood forest dominated by eastern hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghaniensis*). There were smaller areas of eastern white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) forest scattered throughout the ecological landscape, and individual eastern white pine trees were a component of the hemlock-hardwood forest. Harvesting eastern hemlock to support the tanneries was common at the turn of the 20th century, and the species soon became a minor component of forests due to overharvesting and the lack of regeneration.

Forests covered approximately 73% of the North Central Forest Ecological Landscape in 1992, according to WISCLAND (Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data; WISCLAND 1993). The northern hardwood forest is dominant, made up of second-growth stands of sugar maple, American basswood (*Tilia americana*), and red maple (*Acer rubrum*), with scattered individuals or pockets of eastern hemlock, yellow birch, northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), balsam fir (*Abies balsamea*), and eastern white pine. The aspen-birch forest type group is also relatively abundant, followed by spruce-fir (most of this is lowland conifer forest in which black spruce (*Picea mariana*) and/or tamarack (*Larix laricina*) dominate, rather than an upland forest community of white spruce (*Picea glauca*) and balsam fir which is sometimes assumed). In

general, throughout the North Central Forest, there has been a substantial decrease of former dominants such as eastern hemlock, yellow birch, and eastern white pine, while sugar maple and early successional species, especially quaking aspen (*Populus tremuloides*), have increased. A variety of forested and nonforested wetland community types are also present, and wet-mesic forests dominated by northern white-cedar (*Thuja occidentalis*) and/or ashes (*Fraxinus* spp.) are more numerous here than anywhere else in the state.

Many streams and scattered lakes occur within the North Central Forest Ecological Landscape. Major rivers include the Wisconsin, Chippewa, Wolf, Flambeau, Jump, Pine, Popple, and Peshtigo. Several large man-made impoundments have been created, including the Chippewa (Sawyer County), Turtle-Flambeau (Iron County), Gile (Iron County), Pine (Iron County), and Mondeaux (Taylor County) flowages. Although the North Central Forest has one of the most favorable ratings by Wisconsin DNR for overall watershed quality, some lakes have mercury levels high enough to warrant fish consumption advisories due to atmospheric deposition of mercury.

The North Central Forest contains 5.9 million acres of total land area (excluding water) and has the highest percentage of land in forest cover (82%, according to U.S. Forest Service Forest Inventory and Analysis data; USFS 2009) compared to other ecological landscapes. A high percentage of *timberland* (46%) is publicly owned, mostly by federal or county governments. In addition to the publicly owned forests, there are many state wildlife and fishery areas. Important American Indian lands include the Lac Courte Oreilles Reservation and the Forest County Potawatomi Reservation.

Compared to the other ecological landscapes (using county approximations), the population of the North Central Forest counties is growing rapidly from an influx of retirees. On average the population of the North Central Forest counties is much older, less racially diverse, and has lower educational attainment than other ecological landscapes. The population density (19 persons per square mile) is slightly less than one-fifth that of the state as a whole (105 persons per square mile). Interestingly, this region had the fourth fastest population growth rate from 1970 to 2000 with a high percentage of elderly (over 65) and a high median age. The North Central Forest counties have the lowest percentage of minorities, with the exception of American Indians. The percentage of high school and college graduates is below the state average.

Economically, the North Central Forest counties are less prosperous than other ecological landscape county approximations. Government, tourism-related, retail trade, and manufacturing jobs are of high importance whereas service jobs are less important than in other ecological landscape county approximations. Agriculture is not a major contributor to the economy of the North Central Forest counties. In general, the North Central Forest counties have a fairly low per capita income and average wage as well as the third highest unemployment rate of all ecological landscape county approximations.

Environment and Ecology

Physical Environment

Size

The North Central Forest Ecological Landscape encompasses 9,543 square miles (6,107,516 acres), representing 17% of the area of the state of Wisconsin.

Climate

Climate data were analyzed from 17 weather stations within the North Central Forest Ecological Landscape (Drummond Ranger Station, Hayward Ranger Station, Couderay, Weyerhaeuser, Winter, Big Falls Hydro, Holcombe, Jump River, Spirit Falls, Prentice, Park Falls, Mellen, Hurley, South Pelican, Newald, Laona, and Summit Lake; WSCO 2011). This ecological landscape has a continental climate, with cold winters and warm summers, similar to other northern ecological landscapes. The northern ecological landscapes in Wisconsin generally tend to have shorter growing seasons, cooler summers, colder winters, and less precipitation than the ecological landscapes farther to the south. Ecological landscapes adjacent to the Great Lakes generally tend to have warmer winters, cooler summers, and higher precipitation, especially snow, than areas farther inland. As this is a large ecological landscape, with Lake Superior influences in the northwest (higher snowfall in the Penokey-Gogebic Iron Range), higher elevations in the central portion, and a broad range of latitudes, there is considerable variation in local climate.

The growing season averages 115 days (base 32°F), ranging from 85 to 140 days. This growing season length is the shortest of all ecological landscapes in the state. The growing season is almost nine days less than other northern ecological landscapes, excluding the Northern Lake Michigan Coastal Ecological Landscape from this analysis because the influence of Lake Michigan causes the Northern Lake Michigan Coastal Ecological Landscape to have a longer growing season (140 days). Growing season length varied by 55 days among weather stations within the ecological landscape, which can have a marked effect on the ecology throughout the area. The growing season in most of the North Central Forest is too short for agricultural row crops.

The average annual temperature is 40.3°F, the third lowest of any ecological landscape in the state. The average January minimum temperature is -2°F, one degree colder than other northern ecological landscapes. The average August maximum temperature is 79.3°F, the same as the mean of other northern ecological landscapes.

Mean annual precipitation here is 32.3 inches, ranging from 30 to 35 inches. Precipitation in the North Central Forest is similar to the state average and almost 1 inch more than other northern ecological landscapes. Annual snowfall averages 63 inches, ranging from 24 to 139 inches. This is a relatively high amount of snowfall, exceeded only in the Superior Coastal Plain and Northern Highland ecological landscapes.

Snowfall amounts are variable, depending on elevation and distance from Lake Superior.

The cool temperatures and short growing season in the North Central Forest are not adequate to support agricultural row crops, such as corn, in most parts of this ecological landscape. Only 6% of the ecological landscape is in agriculture. The climate is favorable for forests, which cover more than 73% of the ecological landscape.

Bedrock Geology

The North Central Forest Ecological Landscape is primarily underlain by Precambrian bedrock of volcanic and metamorphic origin. See the map "Bedrock Geology of Wisconsin" in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials." The difficulty of characterizing the "Precambrian shield" has been described by Schultz (2004), who noted that this rock has the most complex history of all geologic regions in Wisconsin. Precambrian rocks are more than 1 billion years old and have been subject to considerable metamorphism, erosion, and mixing during their existence.

Although the North Central Forest Ecological Landscape has some prominent bedrock outcrops, most of the area is deeply buried beneath glacial drift, and areas not of interest for mining exploration have not been intensively studied. The shield is made up of many different kinds of rocks; granite and basalt are abundant, and rocks similar in composition to granite are present, including diorite, monzonite, syenite, and rhyolite. Gabbro and anorthosite, rocks of composition much like basalt, are also common. Other rocks include greenstone, a metamorphosed igneous rock; schists; slate; argillite; and quartzite. Rocks of different types and ages do not occur in an orderly and systematic fashion as is often seen in the Paleozoic limestones and sandstones, where more recent deposits lie above older ones. Also, there are almost no Precambrian-age fossils to help identify a sequence of geologic events. Because of these factors, there is still much that is unknown about the Precambrian shield. (Nomenclature used here is according to the Wisconsin Geological and Natural History Survey Open-File Report *Bedrock Stratigraphic Units in Wisconsin*; WGNHS 2006.)

The early Precambrian, also known as the Archean Eon, was the time when the crystalline rock of the shield began forming. The first rocks were created by volcanic action that occurred beneath oceans, eventually forming islands above the water's surface, and subsequently eroding to produce particles that became sedimentary rocks (Dott and Attig 2004, Schultz 2004).

At about 1.89 to 1.82 billion years ago, two ancient land masses, the Superior and the Marshfield continents, collided along a zone that stretches across northern Wisconsin from Osceola on the west to Niagara on the east. Earth's crust was folded, crumpled, and forced upward; geologists refer to this event as the "Penokeyan mountain building episode" (Dott and Attig 2004). Collision and metamorphism allowed intrusions of older granitic rocks to reach the surface; granite is

a lighter rock than most others and tends to “float” to the surface when there is an opening through the Earth’s crust. Exposures of this granite can be viewed around the Gile Flowage, south of Hurley. It is of Archean age, formed around 2.7 billion years ago, and is among the oldest rock exposed in Wisconsin (Clayton 1984).

Iron-rich sandstones deposited by oceans during the lower Proterozoic, about 2 billion years ago, make up the iron formation that was mined in the Hurley area from 1884 until 1967 (Clayton 1984). The iron formation was originally deposited above the granitic rocks of the Penokee-Gogebic Iron Range, but the Penokean mountain building episode forced the older rocks upward through the iron deposit.

At around 1.1 billion years ago, in a process known as rifting, the continent was nearly torn apart. Volcanic eruptions and lava flows occurred in northwest Wisconsin and Upper Michigan over about 20 million years, producing the basalt and rhyolite that outcrops in the Penokee-Gogebic Iron Range and the Copper Range of Upper Michigan (Dott and Attig 2004). Afterward, the crust slowly subsided due to the weight

of the accumulated cooling lava (Figure 12.1). During this time, the heat from the lava allowed mineral deposits to form within the rift. Hot mineral solutions containing dissolved metals moved through cavities in the basalt, leading to the deposition of copper and minor amounts of other metals. Copper was mined from this formation, primarily in Upper Michigan, by American Indians and later by Euro-Americans from about 1850 until the 1970s.

Rift structures can still be detected in rocks beneath Lake Superior and have been traced in underground formations south to Kansas and east to Ontario near Lake Huron. After the period of subsidence, a distant continental collision in eastern North America produced compressive forces that uplifted the central part of the rift at

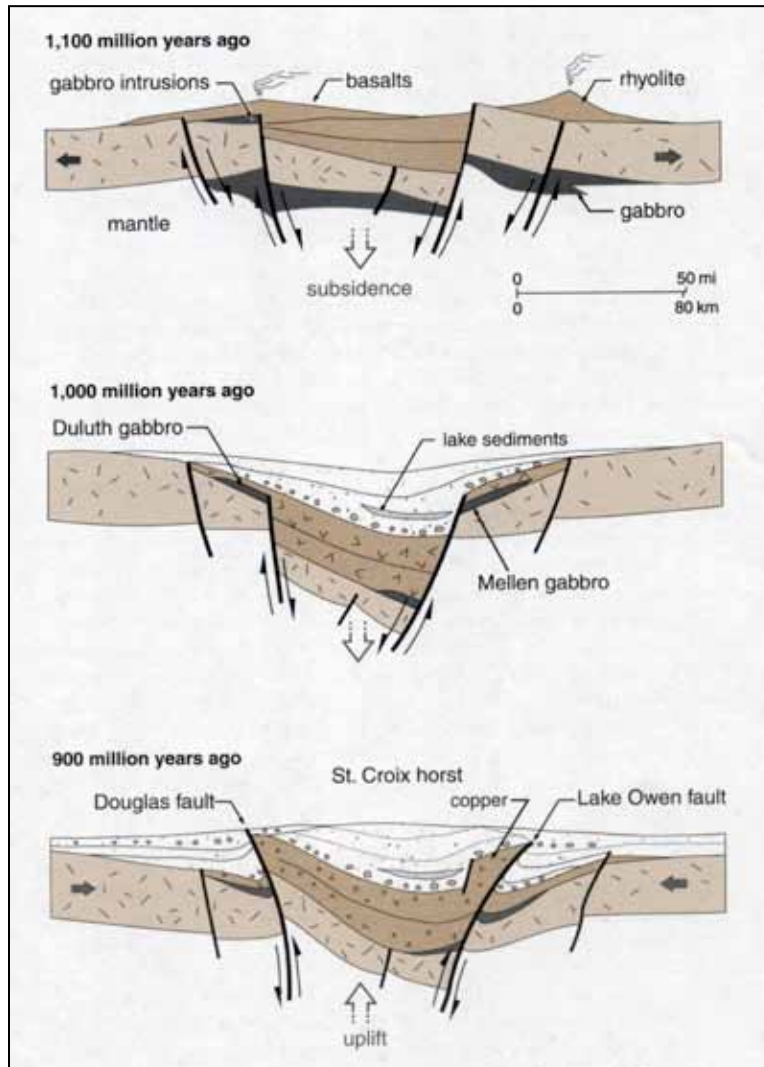
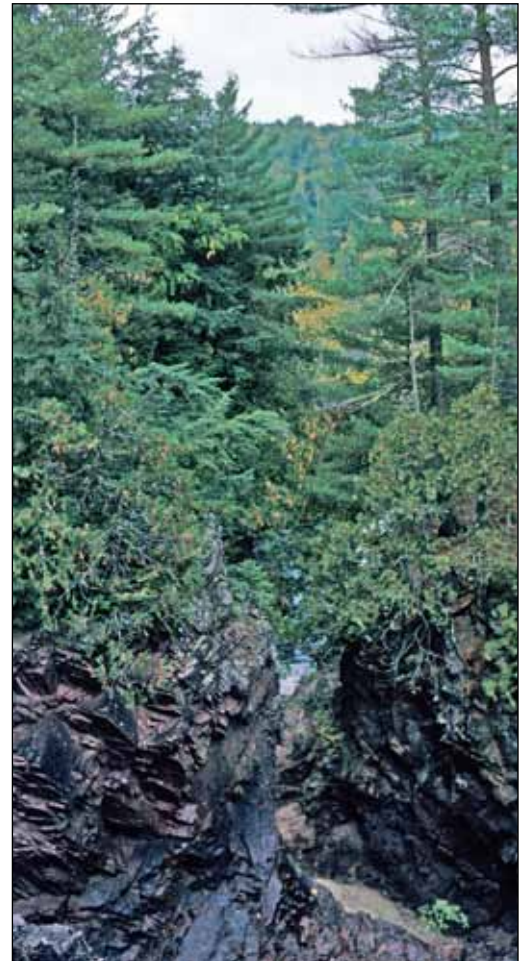


Figure 12.1. Stages in the evolution of the Lake Superior Rift. Figure reproduced from Dott and Attig, *Roadside Geology of Wisconsin* (Missoula: Mountain Press Publishing Co., 2004), 49.



The Bad River and one of its main tributaries, Tyler Forks, have cut deep gorges through the bedrock of the Penokee Range. Cliffs forming the walls of the gorges are continually sprayed with a fine mist. This gorge is forested with conifers such as northern white-cedar, eastern white pine, white spruce, and balsam fir. Ashland County. Photo by Eric Epstein, Wisconsin DNR.

about 1 billion years ago, lifting and exposing the volcanic rocks of the Penokee-Gogebic Iron Range and the Copper Range (LaBerge 1994, Dott and Attig 2004).

The Penokee-Gogebic Iron Range is geologically complex as a result of the varied process of volcanism, metamorphism, erosion, intrusion, and continental collision and rifting (Figure 12.2). The highest hills and cliffs are formed of hard, gray, or reddish igneous rocks that outcrop near Grand View and extend northeastward through the Keweenaw Peninsula of Michigan (Dott and Attig 2004). Volcanic and intrusive rocks of the range include granite, gabbro, anorthosite, basalt, and rhyolite. In Wisconsin, the bedrock outcrops are mapped as Landtype Association 212Jb01, the Penokee-Gogebic Iron Range. Volcanic bedrock of the range is characterized by its hardness and slow rates of mineral weathering, so it is not generally associated with rare species that require unusual mineralogy. It does form deep narrow valleys, usually with moist rock outcrops or cliffs and streams in the valley bottoms, providing shade, moisture conditions, and crevices suitable for certain rare plants, rare snails, bats, and other small mammals. Its exposed dry cliffs also provide unusual habitats associated with certain rare plants.

A relatively small but significant geological feature is found in eastern Barron and western Rusk counties on the border of the ecological landscape. The Blue Hills are formed of Precambrian quartzite deposited over the Penokean granitic bedrock. This formation originated from an extensive deposit of quartz sand at about 1.7 billion years ago. The quartzite is believed to be of the same origin as the Baraboo Hills as well as a deposit in southwestern Minnesota. These formations all have a similar appearance; they are reddish-purple and have obvious strata of ripple marks typically seen when sand is deposited from oceans. These oceans apparently persisted over a long period of time because quartzite at the Blue Hills (Landtype Association [LTA] 212Xe02) is 1,300 feet thick and at the Baraboo Hills is 4,000 feet thick (Dott and Attig 2004). See the map "Landtype Associations of the North Central Forest" in Appendix 12.K at the end of this chapter.

McCasin Mountain, located on the southeastern edge of Forest County and extending into Marinette County, is part of another notable quartzite outcrop associated with the McCasin syncline. Like the Baraboo Hills syncline, the rocks are folded downward in the center and rise up at the edges to form outcrops. The McCasin

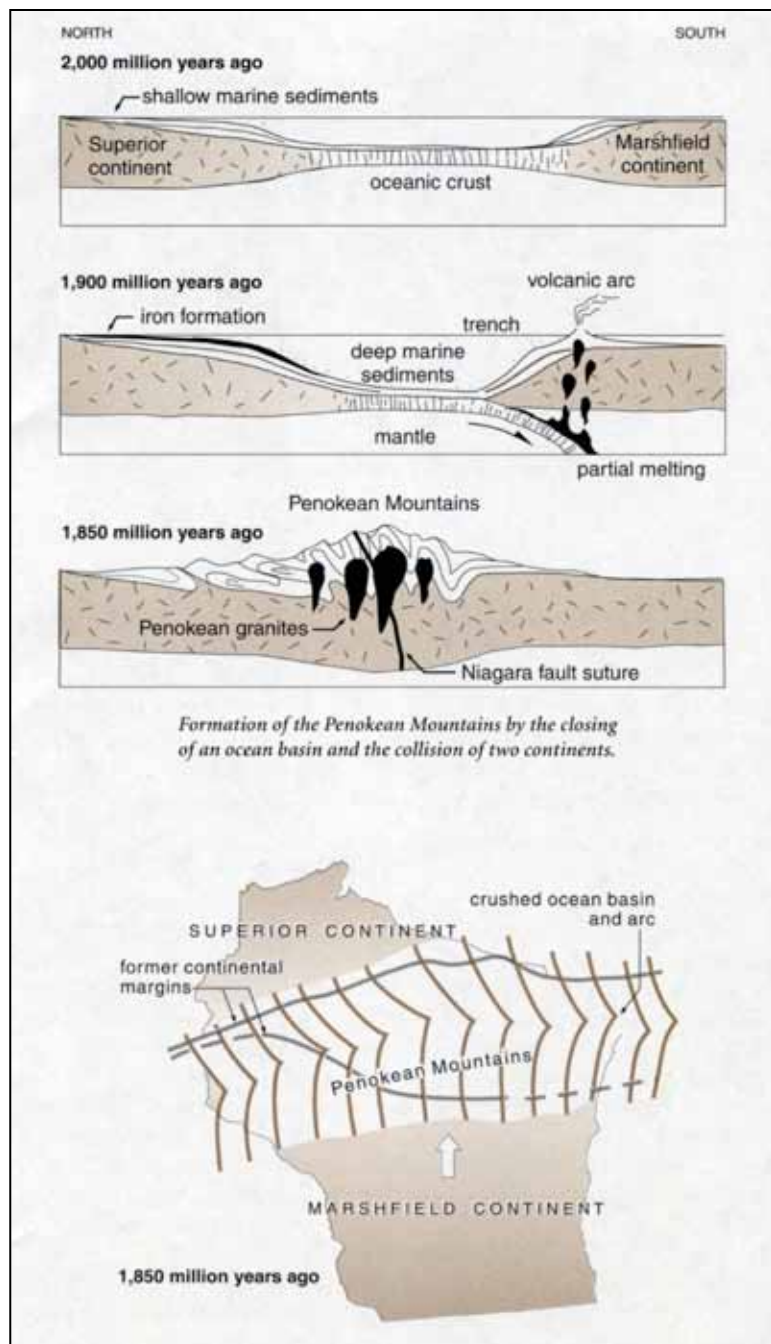


Figure 12.2. Formation of the Penokee Mountains. Figure reproduced from Dott and Attig, *Roadside Geology of Wisconsin* (Missoula: Mountain Press Publishing Co., 2004), 42.

Mountain portion is on the northern arm of the syncline, an outcrop about 4 miles long. The center of the syncline was intruded by rhyolite and granitic rocks of the Wolf River Batholith, burying the quartzite. The tip of the syncline's southern arm features an outcrop at Thunder Mountain, about 8 miles to the southeast, in the Northeast Sands Ecological Landscape. The quartzite of the McCasin syncline is gray to reddish with quartz crystal inclusions and is about the same age as quartzite at the Blue Hills and Baraboo Hills (Dott and Attig 2004).

Cambrian sandstones, some containing brachiopod fossils, are the uppermost bedrock layer along the southwest edge of the ecological landscape and are much more extensive to the south in the Forest Transition Ecological Landscape. The Cambrian sandstone is the youngest bedrock found in the North Central Forest. A few outliers of this sandstone can be found at some distance away from the main deposit, including one at the top of Irma Hill just east of the village of Irma (Dott and Attig 2004).

Other than the notable outcrops and anomalies described, most of the ecological landscape is underlain by a complex assortment of Precambrian igneous and metamorphic rocks, including basalt and rhyolite with some areas of granite, gneiss, and amphibolite, and small areas of metasedimentary rocks. There are a number of additional small exposures of bedrock within the ecological landscape; some of these locations are given in regional and county-level reports from the Wisconsin Geological and Natural History Survey (Clayton 1984, Attig 1985, Simpkins et al. 1987, Attig 1993, Ham and Attig 1997).

Landforms and Surficial Geology

Most of the surface formations of the North Central Forest are due to glacial activity during the late Wisconsin glaciation, about 25,000 to 11,000 years ago. Glacial till is thin in the Penokee-Gogebic Iron Range and at a few other places where bedrock outcrops, but typically glacial materials are 50–100 feet thick over bedrock and can be up to several hundred feet thick.

Glacial materials are part of the Copper Falls Formation, deposited by the Chippewa, Wisconsin Valley, and Langlade

lobes, with a small amount of Superior Lobe material in the far western part of the ecological landscape. Landforms include end and ground moraines, kettles, pitted outwash, drumlins, eskers, ice-walled lake plains, outwash channels, and outwash plains. Eskers and drumlins are particularly interesting glacial features, and a number of them are represented within *state natural areas* (Table 12.1). Nearly the entire ecological landscape is underlain by glacial till that impedes drainage, so it includes many areas of poorly and very poorly drained soils and has numerous lakes and wetlands. A mantle of loess derived from postglacial wind transport of silty material from lakebeds and *alluvial fans* along streams covers nearly the entire ecological landscape. Much of the loess was later moved downslope by erosional forces of water or gravity, so thicknesses vary locally but generally range from 6 to 24 inches (Hole 1976, Simpkins et al. 1987).

The North Central Forest contains areas with distinctly different types of glacial features, due in part to the shape of the underlying material, which in many places was formed by previous glaciations. Some of the ecological landscape is underlain by bedrock, which also influenced the type and amount of glacial material deposited. Several different lobes of the late Wisconsin glaciation were responsible for deposition in this large ecological landscape, and each lobe had a slightly different composition and pattern of advance and retreat.

The Penokee-Gogebic Iron Range (Subsection 212Jb) is predominantly a bedrock-controlled moraine. Bedrock was modified by glacial activity throughout the Wisconsin glaciation. A thin layer of till is draped over the bedrock surface, deposited by the Chippewa Lobe at about 11,000 to 11,500

Table 12.1. *State natural areas where glacial features can be observed.*

State Natural Area ^a	County	Glacial features represented
Black Creek Bog	Ashland	Eskers, drumlins
East Fork Chippewa River	Ashland	Drumlins
Lauterman Lake	Florence	Eskers
Alvin Creek Headwaters	Forest	Drumlins
Rat Lake Swamp and Popple River Headwaters	Forest	Eskers, drumlins
Wabikon Lake	Forest	Eskers
Foulds Creek	Price	Eskers
Little Willow Drumlin	Price	Drumlins
Memorial Grove Hemlocks	Price	End moraine
Riley Lake	Price	Eskers
Ghost Lake	Sawyer	Eskers
Thornapple Hemlocks	Sawyer	Drumlins
Snoose Creek	Sawyer-Ashland	Drumlins
Spring Brook	Sawyer-Ashland	Drumlins
Wilson Lake	Sawyer-Bayfield	Eskers
Lost Lake Esker	Taylor	Eskers, end moraine
Mondeaux Hardwoods	Taylor	Eskers
Perkinstown Hemlocks	Taylor	End moraine
Pirus Road Swamp	Taylor	End moraine
Richter Lake Hemlocks	Taylor	Ice-walled lake plain, end moraine
Yellow River Ice-walled Lake Plain	Taylor	Ice-walled lake plain, end moraine

^aFor more information about these places, see the Wisconsin State Natural Areas program web page (WDNR 2013c).

years ago. Rolling and hilly ground and end moraines are present, overlain with drumlins near the Michigan border. Till surfaces are typically hummocky, formed of **supraglacial till** material (on top of glacial ice) that collapsed as the ice melted. On the northern side of the Penokee-Gogebic Iron Range, drainage channels of **proglacial** streams can be found, along with features related to glacial lakes that formed ahead of the retreating ice sheet when drainages out of the Lake Superior basin to the east were blocked by ice. The Gurney/Ontonagon Spillway (Landtype Association 212Jb05) is dominantly made up of collapsed stream sediment of the Glacial Lake Ontonagon spillway. Glacial Lake Ontonagon stood in the central part of western Upper Michigan from about 11,500 to 9,500 years ago (Clayton 1984). It was blocked from northward flow by the ice sheet and by the range of bedrock outcrops known as the Trap Hills, so it drained westward into Glacial Lake Duluth (Jordan 2000, Jerome 2006). The spillway was located north of Hurley and extends westward past Saxon (Martin 1965, Clayton 1984). Glacial Lake Ontonagon “probably stood about 167 feet higher than Glacial Lake Duluth,” and its highest shorelines are found at present elevations of 1,320 to 1,340 feet (Martin 1916). Clayton (1984) noted that Glacial Lake Ontonagon may have drained suddenly when an ice dam was

breached, creating a flood that could possibly explain the large capacity of the St. Croix spillway in what is now the Brule River valley. Shoreline features of Glacial Lake Duluth, which at its maximum elevation was 450 to 500 feet higher than present-day Lake Superior, can be seen at elevations of about 1,082 feet and lower (Martin 1916, Clayton 1984, Jordan 2000).

To the south and east of the Penokee-Gogebic Iron Range are the **Winegar Moraines** (Subsection 212Jc), which extend through northern Vilas County and into Upper Michigan. These end moraines were formed by the Chippewa Lobe on the west and the Ontonagon Lobe on the east. It is the only Ontonagon Lobe material in Wisconsin, deposited by a readvance of the ice sheet after the Langlade and Wisconsin Valley lobes had retreated (Figure 12.3). The Winegar Moraines are characterized by rolling collapsed end moraines with abundant swamps and lakes. Topography is irregular and hummocky, with kettles and steep hillslopes common. The dominant landforms were developed by the draping of supraglacial till and outwash over an older surface from previous ice advances and over stagnant ice blocks that collapsed as they melted. Ice-walled lake plains, formed from sediment deposited into glacial lakes on top of the ice, dot the ecological landscape at some of the highest elevations and have a flat to

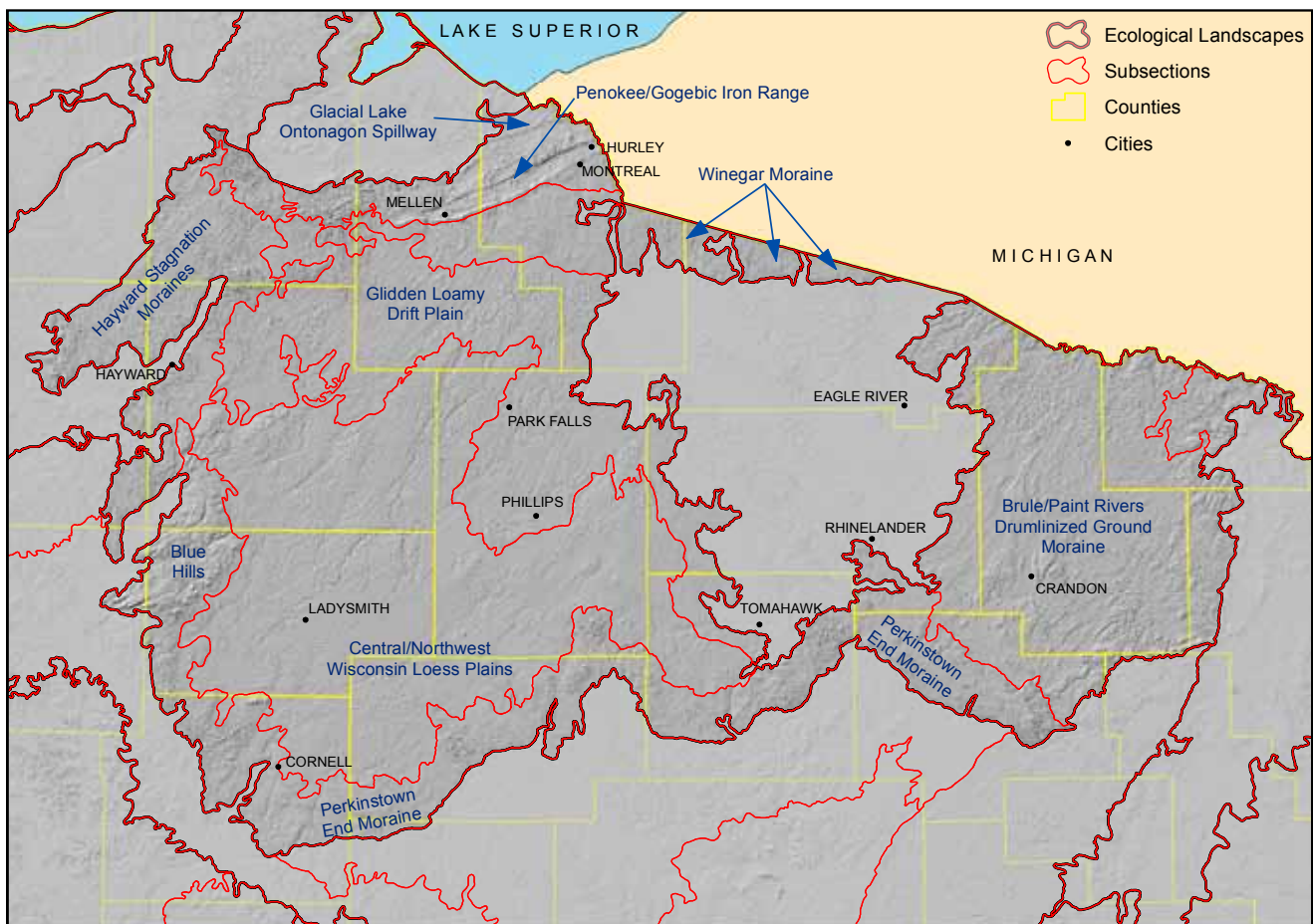


Figure 12.3. Landforms of the North Central Forest Ecological Landscape.

low-relief topography. Eskers that occur at several locations in northern Vilas County are the result of gravels deposited by rivers flowing in subglacial tunnels (Attig 1985).

Southwest of the Penokee-Gogebic Iron Range lies the Hayward Stagnation Moraines (Subsection 212Xf), a region of loamy till moraines formed as interlobate features by the Chippewa and Superior lobes. These moraines have a hummocky topography resulting from supraglacial till and proglacial stream sediments being deposited unevenly along the ice margins between two ice lobes as well as from the collapse of buried ice blocks. Many of the landforms and the glacial processes that created them are similar to those of the Winegar Moraines. Ice-walled lake plains are notable in the Birchwood Lakes area in Washburn County (Birchwood Lakes LTA, 212Xf07). Eskers can be seen near the Bayfield-Sawyer County border and also west of Hayward (Clayton 1984).

The Glidden Loamy Drift Plain (Subsection 212Xa) includes a till plain and an outwash plain associated with the Chippewa Lobe, located mainly in southern Ashland County and northern Sawyer and Price counties. Drift material from the Chippewa Lobe was deposited during several phases of glacial retreats and minor readvances. The area is dominated by undulating landforms molded beneath the ice sheet; drumlins are especially common in southern Ashland County (Glidden Drumlins LTA, 212Xa01). These drumlins are thought to have first formed in an earlier glacial episode and were only partially remolded during the most recent phase of glacial activity. The drumlins consist of dense till and are commonly cored by older till or stream-deposited sand and gravel. Nondrumlin areas, along with areas between drumlins, are filled with collapsed and uncollapsed sediments from meltwater streams, typically sandy and gravelly material that flowed out of the retreating ice sheet. Eskers are also quite common here, especially near the Turtle-Flambeau Flowage (Clayton 1984). Some of them have been mined for gravel, but many examples still exist; a notable one can be viewed extending into the flowage just west of the Springstead boat landing.

The Central-Northwest Wisconsin Loess Plains (Subsection 212Xd) occupies a large area in the southwest part of the ecological landscape. It is characterized by extensive till plains as well as drumlins and outwash deposited by the Chippewa and Wisconsin Valley lobes. Much of the ecological landscape has an undulating topography formed beneath the ice sheet of dense till. The surface is overlain by a 6- to 24-inch-thick mantle of loess (Hole 1976). Drumlins are common and tend to be oriented toward the southwest (Albert 1995). Drumlins are more prevalent in the northern part of the Subsection where they are thought to have formed in an earlier glacial episode with partial remolding during the most recent phase of glaciation. Collapsed, pitted, and unpitted meltwater stream sediments are found between drumlins and along major rivers as outwash plains, terraces, and fans. Postglacial stream cutting and deposition further contributed to the formation of floodplains, terraces, and swamps along rivers. Eskers, partially mined for gravel, are located in the Mondeaux and

Upper Steve Creek flowages in northern Taylor County (Attig 1993). Much of this area does not currently have a detailed geologic report; however, maps and reports are available for Taylor and Lincoln counties.

The Perkinstown End Moraine (Subsection 212Xe) lies along the southern border of the ecological landscape in a long, uneven strip of hills that extends for approximately 170 miles and crosses most of the width of northern Wisconsin. This end moraine system marks the southern limit of the last major advance of the Wisconsin glaciation (about 25,000 years ago). Various portions of the end moraine were deposited by the Chippewa, Wisconsin Valley, and Langlade lobes. It is a complex morainal system with varied landforms. Topography ranges from level to hummocky, due in part to the uneven deposition of supraglacial till along the ice margin and from the collapse of buried ice blocks as they melted. Collapsed, pitted, and unpitted meltwater stream sediments formed features such as outwash plains, terraces, and heads of outwash, which are interspersed among the morainal hills. Ice-walled lake plains frequently occur on the higher elevations. Several eskers are mapped in Langlade County north of Antigo (Mickelson 1986). At the western extent of the end moraine system in the Blue Hills, till was draped over pre-Pleistocene rock which strongly influenced the shape of glacial features. The Harrison Hills, northeast of Irma in Lincoln County, provide good examples of the complex hummocky and pitted topography characteristic of an end moraine system as well as the flat areas created by ice-walled lakes (Ham and Attig 1997). Another location for viewing end moraine features is the Perkinstown Hemlocks State Natural Area in Taylor County.

The Brule and Paint Rivers Drumlinized Ground Moraine (Subsection 212Xc) occupies the eastern portion of the ecological landscape. It has features similar to that of the Glidden Loamy Drift Plain, but the till and outwash plains here were deposited by the Langlade Lobe. Many drumlins occur on the till plain, notably the Wabeno and Bass Lake Drumlins (LTAs 212Xc06 and 212Xc09). These drumlins contain materials characteristic of earlier ice advances, indicating that they were already formed prior to the most recent advance. In some locations, recent till overlies the drumlins while in other areas there is little or no till on them (Simpkins et al. 1987). Areas between drumlins and in nondrumlin areas are filled with sand and gravel sediments from meltwater streams and are often covered with silty loess deposits 6 to 24 inches thick (Hole 1976, Albert 1995). Eskers are mapped at a number of locations in Forest and Florence counties, and some mining for sand and gravel has occurred (Simpkins et al. 1987). Bedrock-controlled knolls and ridges are common in the northeastern and southwestern parts of the Subsection.

For details on Sections and Subsections (Cleland et al. 1997), see the "Introduction" to this book in Part 1 and also the "Ecological Landscapes, NHFEU Provinces, Sections, and Subsections" map in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials." A map showing the Landtype

Associations (WLTA Project Team 2002) in this ecological landscape, along with the descriptions of the Landtype Associations, can be found in Appendix 21.K.

Topography and Elevation

Land surface elevation ranges from 853 to 1,951 feet (260 to 595 meters). The lowest point is along the Montreal River and the former Glacial Lake Ontonagon spillway in the far northern extent of the ecological landscape. Timm's Hill, the highest point in Wisconsin, is located 6 miles east of Ogema in Price County. Along with the Northern Highland Ecological Landscape, the North Central Forest has the highest elevations in the state because of the upwarping of the underlying Precambrian shield bedrock as well as deposition from multiple glacial events. In general, most elevations are lower in the southwest and rise gradually toward the Northern Highland Ecological Landscape.

Topography throughout most of the ecological landscape is typical of glacial moraines and till plains, with a varied land surface that can be nearly level, gently sloping, undulating, rolling, or steep. The escarpments of the Penokee Range are some of the most striking topographic features; the steepest slopes are in the eastern part of the range where bedrock outcrops are most common. The collapsed morainal topography of the Winegar Moraines, with many wetlands and lakes, is another area with a dramatic land surface. Drumlins and eskers are other topographic features of interest, along with the hummocky surface and varied glacial landforms of the Perkinstown End Moraine.

Soils

Upland soils of the North Central Forest are typically reddish-brown or brown noncalcareous glacial till ranging in texture from loamy sand to sandy loam and loam, while some of the soils are outwash sands. A mantle of loess 6 to 24-inches thick covers nearly the entire ecological landscape (Hole 1976). The reddish color of most of the glacial till soils is derived from material moved from the Lake Superior basin, likely originally derived from Precambrian sediment such as the Keweenaw sandstones (Clayton 1984). Upland soils range from well drained to somewhat poorly drained; they have slow to moderately rapid permeability and low to moderate available water capacity. Nearly the entire ecological landscape is underlain by till that impedes drainage, so there are many areas of poorly and very poorly drained soils, and few areas of well drained soils. Organic soils are typically acid peat or nonacid muck and are poorly or very poorly drained, and there are many additional wetland soils with a shallow water table in outwash sands or loamy alluvial deposits. The "Soil Regions of the North Central Forest" map in Appendix 12.K at the end of this chapter indicates the general textures of soils in the North Central Forest, classing them as silty or loamy, with many interspersed wetland soils.

Soils within the ecological landscape vary, primarily due to differences in parent materials deposited by glaciation and

the influence of underlying material such as bedrock or older till. The Penokee Range has soils that are shallow to bedrock as do the Blue Hills and a few other locations. Till soils in the Penokee Range are typically sandy loams or silt loams, well drained to moderately well drained, with moderately slow permeability and moderate available water capacity. Glacial spillways and drainageways have soils formed in loamy alluvium over acid outwash gravel, and most lowland soils are very poorly drained nonacid muck or poorly drained outwash or loamy till.

Soils of the Winegar Moraines are also typically sandy loam till but are highly variable in end moraines. Till soils are intermixed with soils formed in loamy alluvium over acid outwash sand and gravel and with soils formed in loamy lacustrine deposits. Lowland soils are very poorly drained acid peat or nonacid muck but include poorly drained outwash or loamy till.

The Hayward Stagnation Moraines (Subsection 212Xf) also have variable soils as is typical of an interlobate moraine. They are predominantly formed in noncalcareous dense loamy sand till, some with a loess mantle, and in outwash. Dense till was deposited beneath a moving ice sheet when the weight of the ice was sufficient to bring it to its "pressure melting point" even at temperatures below freezing. Under these conditions, glacial debris was deposited out of the melted ice, subjected to processes of grinding and sliding that oriented particles along the direction of ice flow, and compacted by the weight of the ice sheet. Dense till deposited in this manner has a high bulk density and limits moisture infiltration. Because of the underlying dense till, the dominant soil in the Hayward Stagnation Moraines is moderately well drained and has moderately slow permeability and moderate available water capacity. Soils formed in loamy alluvium over acid outwash sand and gravel, or entirely in outwash sand and gravel, are interspersed with areas of till and also occur in glacial drainways. Most lowland soils are poorly drained loamy till or very poorly drained nonacid muck.

On the Glidden Loamy Drift Plain (Subsection 212Xa), most soils formed in noncalcareous dense loamy sand till or in outwash sands and gravel, some with a loamy alluvium mantle. They are dominantly moderately well drained, with moderately slow permeability and moderate available water capacity. Most lowland soils are very poorly drained acid peat or nonacid muck, but include poorly drained outwash.

Upland soils of the Central-Northwest Wisconsin Loess Plains (Subsection 212Xd) were mostly formed in loess over reddish-brown noncalcareous dense sandy loam till. The dominant soil is moderately well drained and loamy with a silt loam surface, with moderately slow permeability and moderate available water capacity.

Most upland soils of the Perkinstown End Moraine (Subsection 212Xe) were formed in reddish-brown, noncalcareous, dense sandy loam till, some with a loess mantle. The dominant soil is moderately well drained, with moderately slow permeability and moderate available water capacity; however, this

is an end moraine complex, so soil characteristics are highly variable. Drainage classes range from well drained to somewhat poorly drained, and permeability can be moderate to very slow. Quartzite bedrock underlies soils in the Blue Hills segment of the end moraine. In the eastern part of the end moraine, upland soils were typically formed in brown, non-calcareous, nondense loamy sand till. Soils formed in loamy alluvium over acid outwash sand and gravel are found in glacial drainways. Ice-walled lake plains have soils formed in silty lacustrine material which tends to be more productive than surrounding soils and consequently many ice-walled lake plains are cultivated for agricultural crops. Most lowland soils are poorly drained loamy till or very poorly drained nonacid muck but also include poorly drained outwash. The major river valleys have loamy alluvial soil or nonacid muck.

Soils of the Brule and Paint Rivers Drumlinized Ground Moraine (Subsection 212Xc) were primarily formed in either brown noncalcareous loamy till or outwash sands. The dominant soil is well drained and loamy with a sandy loam surface, moderate permeability, and moderate available water capacity. Many other upland soils formed in acid outwash sand and gravel, commonly with a loamy alluvium mantle. Soil characteristics range from well drained to somewhat poorly drained, moderately rapid to moderate permeability, and low to moderate available water capacity. Soils on drumlins and moraines formed in brown noncalcareous loamy sand to sandy loam till with a fragipan. There are large areas of lowland soils due to impeded drainage from the underlying dense till; most wetlands are very poorly drained acid peat or nonacid muck, but some are poorly drained outwash sands. A small area of the Crystal Falls Till and Outwash Subsection (212Xq) is in Wisconsin at the far northeast corner of the ecological landscape; it also has brown loamy till soils, but igneous and metamorphic bedrock exposures are common.

Hydrology

The North Central Forest is home to several of Wisconsin's most physically unaltered and *ecologically intact* rivers and streams. It hosts many lakes, including some smaller lakes with little to no development and healthy, undisturbed populations of native aquatic plants, fish, and other fauna. The significant diversity of aquatic insects, mollusks, and other organisms here is dependent upon very good water quality, and in turn many of these organisms provide the ecosystem services that remove and store excess nutrients, thereby helping to maintain water quality. This diversity also helps make the aquatic communities more resilient in the face of ecological changes so that ecosystem functions are more likely to continue. A number of these species are secure in this ecological landscape because of its abundance of high quality streams and lakes that are less common to rare elsewhere (with the exception of the high quality waters of the Northern Highland). Large areas of compact, low-permeability soils formed from glacial till provide the setting for large areas of wetland community types, which also contribute to high water quality.

Basins

Eight of Wisconsin's 24 major water basins drain the North Central Forest Ecological Landscape (see the "Water Basins" map in Appendix G, "Statewide Maps," in Part 3, "Supporting Materials"). The Upper Chippewa basin dominates the western half of this ecological landscape, draining about 60% of its total land area. This basin contains the headwaters of several streams, including the Flambeau and Chippewa rivers, which figure prominently in supporting Wisconsin's aquatic ecological diversity and contributed significantly to its cultural history. The remainder of the western half of the North Central Forest Ecological Landscape is within the St. Croix and Lake Superior basins. The Upper Wisconsin basin comprises the center of this ecological landscape, while the Green Bay basin dominates the eastern portion. A portion of the eastern part, within Langlade and Forest counties, is within the Wolf River basin. Small portions of the ecological landscape lie within the Central Wisconsin and Lower Chippewa basins.

Overall water quality in lakes and streams is very good. For example, the headwaters of a number of Wisconsin's cleanest and most renowned streams arise here, namely, the Pine, Popple, Peshtigo (Forest and Marinette counties), Oconto (Oconto County), and Wolf rivers, all of which originate in or near the Headwaters Wilderness Area of the Chequamegon-Nicolet National Forest. Activities that can negatively impact water quality are relatively very limited in this headwaters area. Other streams, including the Chippewa, Flambeau, and Jump rivers originate in forested areas with limited development and maintain high water quality because they are generally not adversely impacted by forest management operations and other activities.

Sediment and pollutant loads are low, and the diversity of aquatic organisms is significant for both common and rare species that are pollution-sensitive. In large part, this may be attributed to the high percentage of land in forest rather than in agricultural or urban-industrial cover throughout the North Central Forest, a factor that has protected this ecological landscape's waterbodies from the negative impacts of many pollutants, siltation, temperature increases, and loss of bank stability, all of which are more severe problems elsewhere in the state. Public and many private forest managers now routinely include provisions to protect water quality as part of their land management practices. Most 303(d) impaired waters here were designated as such because of atmospherically deposited mercury found in fish tissue, originating from coal combustion and other industrial activities.

Susceptibility to groundwater pollution is rated as low in most watersheds of this ecological landscape (see Appendix 12.A at the end of this chapter), which is reflected in the findings of overall good groundwater water quality. The few areas ranked as "High" (highly susceptible to groundwater pollution) generally feature lakes with high levels of shoreline development and coarse textured, porous soils, making them vulnerable to pollutants from failing septic systems, lawn chemicals, and other residential runoff. A high susceptibility

rating does not necessarily mean that groundwater is polluted or that surface water is being fed by polluted groundwater.

Inland Lakes

The North Central Forest contains numerous lakes of diverse types, among which are some of the state's most popular waters for recreation and residential development (both vacation homes and permanent dwellings). According to the Wisconsin DNR's 24K Hydrology Geodatabase, this ecological landscape has more named lakes than any other and the second-highest number of unnamed lakes (WDNR 2012a). There are 1,734 named lakes with a total surface area of 124,301 acres, and 11,468 unnamed lakes with a total surface area of 21,992 acres. Nearly 150 of these lakes, including 44 named lakes, sustain wild rice (*Zizania* spp.) populations (GLIFWC 2003).

A large number of lakes in the North Central Forest Ecological Landscape have been identified through a program of water quality sampling by the Wisconsin DNR's Watershed Management program as having very good water quality and habitat values, including Grindstone, Lac Court Oreilles, Round ("Big Round"), Sand, and Whitefish lakes (all in Sawyer County) and Stone Lake (in Washburn County). Numerous lakes have been recommended as candidates for implementing critical habitat surveys in order to determine if they should be designated as Sensitive Areas, which limit disturbance by watercraft and other activities to protect critical aquatic habitat from inadvertent damage. Maintaining forest cover and minimizing impermeable areas within each lake's watershed are essential to maintain high water quality and overall lake health.

Lakes with substrates and shorelines suitable for residential and recreational uses generally have substantial development. This is especially true for larger lakes of 50 acres or more. Several clusters of smaller lakes (generally less than 50 acres) have escaped development and the concomitant loss of ecologically significant aquatic and shoreline habitat and are candidates for designation as Conservation Opportunity Areas by the Wisconsin Wildlife Action Plan (WDNR 2008b). Clusters of these candidate lakes tend to be associated with rugged terminal or recessional moraines, such as the Chippewa Moraine, Birchwood Moraine, Harrison Hills, and Winegar Moraine. As of 2007, no definitive studies had been compiled at these sites similar to those conducted under the U.S. Geological Survey Gap Analysis program for flowing waters (USGS 2007), many unsampled lakes in this ecological landscape may be centers of high biological diversity for invertebrate species that require high quality, undisturbed habitats (W.A. Smith, Wisconsin DNR, personal communication).

Past glacial action, drainage patterns, and bedrock characteristics have created lakes demonstrating a wide range of sizes and types within the North Central Forest. Among the larger and more heavily used lakes in the western part of the ecological landscape are Namekagon (2,897 acres – Bayfield County); Lac Courte Oreilles (5,039 acres), Grindstone (3,111 acres),

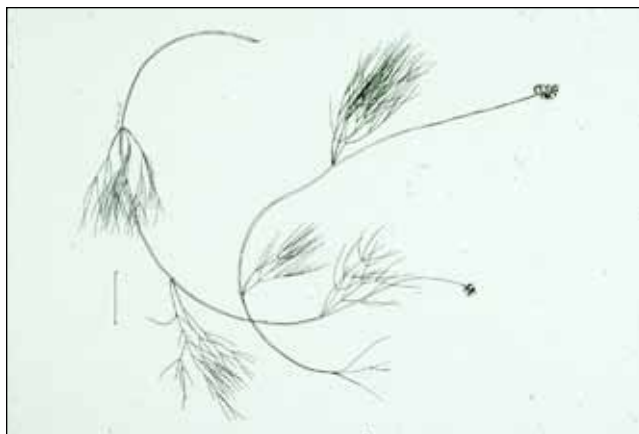
Nelson (2,503 acres), Lost Land (1,304 acres), Owen (1,323 acres), and Round (3,054 acres) (all in Sawyer County); Butternut Lake (983 acres – Price and Ashland counties), and the Eau Claire Lakes chain (Douglas and Bayfield counties). In the eastern part of the North Central Forest Ecological Landscape, large lakes include North Twin (2,788 acres) and Long (886 acres) (Vilas County); Pelican (3,585 acres – Oneida County); Kentuck (950 acres – Forest and Vilas counties); and Pine (1,670 acres), Pickerel (1,299 acres), Lucerne (1,005 acres), Butternut (1,246 acres) and Metonga (2,157 acres) (all in Forest County). All of these lakes are at least partially developed (some are heavily developed) and important sites for water-based recreational activities. These and numerous smaller lakes are also used heavily by anglers pursuing game fish such as walleye (*Sander vitreus*), largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*), northern



This large undeveloped drainage lake is within the headwaters for Monico Creek. The lake is situated at the edge of a vast acid peatland. The immediate shoreline includes areas of sedge meadow, open bog, and muskeg, and in some years the lake basin supports beds of wild rice. Atkins Lake, Chequamegon-Nicolet National Forest, Forest and Oneida counties. Photo by Eric Epstein, Wisconsin DNR.



This shallow, softwater seepage lake on the Winegar Moraine supports the Wisconsin Threatened algae-like pondweed (*Potamogeton confervoides*). Vilas County. Photo by Eric Epstein, Wisconsin DNR.



Algae-like pondweed has been documented in only a few lakes in Wisconsin. Vilas County. Drawing by Jim McEvoy.

pike (*Esox lucius*), muskellunge (*Esox masquinongy*), and a host of panfish species.

Several rare lake types occur in the North Central Forest. For example, **marl** lakes have pH levels as high as 8.4 (Shaw et al. 2004). In these lakes, calcium carbonate (marl) precipitates and accumulates on the lake bottom and sometimes encrusts the aquatic vegetation. There are also extremely **oligotrophic**, clear, deep, hard-bottomed seepage lakes with circumneutral pH water supporting plants with very restricted distributions in Wisconsin. Lakes of this type are most common in the Northern Highland Ecological Landscape, but good examples also occur within the Chequamegon-Nicolet National Forest in northwestern Forest County within the North Central Forest Ecological Landscape.

Meromictic lakes are another very rare lake type in Wisconsin (as well as world-wide, constituting less than 0.1% of all lakes on Earth). These lakes are unusual because they generally have very small surface areas of only a few acres, great depth, and demonstrate permanent **stratification**. Most deep inland lakes in Wisconsin thermally stratify seasonally and have spring and fall periods of **turnover**. On these occasions, the top and bottom layers of water reach nearly the same temperature, so that a wind event will mix the layers and introduce oxygenated water throughout the lake's depths. Meromictic lakes rarely, if ever undergo this mixing, and therefore have an anoxic bottom layer, which may include a large portion of the lake's volume. The bottom portion of meromictic lakes is characterized by a naturally occurring salinity and often by highly stained waters that inhibit the penetration of light. Both factors contribute to the lack of mixing in the water column.

The anoxic bottom layer is often home to a strain of purple bacterium that uses sulfur compounds to achieve photosynthesis. Because the sediment layer of these lakes is relatively undisturbed as well as anoxic, organic materials do not decay, and the sediments make good research sites for climate, vegetation, and other trends (Hakala 2005). Six meromictic lakes have been described from the North Central Forest, including

three lakes within the Perkinstown Moraine (LTA 212Xe05) in Taylor County and three within the Pikes Peak Moraine (LTA 212Xe04) in the Chippewa County forests (Garrison et al. 2006). One other Wisconsin meromictic lake in the Northern Highland Ecological Landscape has been studied extensively since the 1920s. There may be as few as 10 other meromictic lakes known within the United States.

Descriptions of lake types recognized by the Wisconsin Natural Heritage Working List may be found in Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 of this publication. This provides a similar but more detailed waterbody classification than what was used in the development of Wisconsin's Wildlife Action Plan (WDNR 2005b).

Impoundments

Large impoundments have been constructed on several of the major rivers here. Notable examples include the 15,300-acre Chippewa Flowage on the Chippewa River and the 13,766-acre Turtle-Flambeau Flowage on the Manitowish (Vilas and Iron counties), Little Turtle (Iron County), and Flambeau rivers (WDNR 2012a). Other significant impoundments include 3,890-acre Holcombe Flowage on the Chippewa River (Rusk and Chippewa counties), 3,384-acre Gile Flowage on the West Fork of the Montreal River in Iron County, 2,714-acre Miller Dam Flowage ("Chequamegon Waters") on the Yellow River in the Chequamegon-Nicolet National Forest in Taylor County, 1,911-acre Tigercat Flowage on the Twin Lakes Chain in Sawyer County, and 1,745-acre Dairyland Reservoir on the Flambeau River in Rusk County. Five named impoundments in this ecological landscape support wild rice populations (GLIFWC 2003).

Several of these impoundments support good populations of muskellunge, walleye, and other game fish, the most fabled among them being the Chippewa Flowage. Overall, northern Wisconsin lakes and flowages (impoundments) are generally more susceptible to mercury accumulation in fish tissue than those in the southern part of the state. Mercury concentrations in fish from Turtle-Flambeau, Chippewa, and Dairyland flowages are especially high due to interactions of several factors. Prime among these are the surface area of wetlands, both along the reservoir's shores and inland, that are subject to inundation as the reservoir fills and the manner in which the reservoir is operated. A greater degree of water level fluctuation exposes more wetlands and other shoreline vegetation to flooding, which promotes the conversion of more elemental mercury from atmospheric deposition to methyl mercury. This methyl mercury then enters the impoundment as the water levels subside and is introduced into and concentrated through the food chain (Groetsch et al. 2003).

There are 511 (as of 2013) existing dams in the North Central Forest Ecological Landscape. Over the past several decades, 189 dams have been removed to improve habitat for aquatic organisms by reestablishing free-flowing stream reaches or to address concerns or conflicts over dam safety,

ownership, or other situations (Wisconsin DNR unpublished data). Dams can be significant barriers to the movements of aquatic animals, including fish species that serve as intermediate hosts for a variety of mussel species. Loss of sedge, marsh, and wild rice habitat have occurred due to raised water levels from dam construction (American Rivers 2002).

Rivers and Streams

Approximately 4,850 miles of perennial rivers and streams flow from or across the North Central Forest Ecological Landscape (WDNR 2012a). These range from cold springs and stream headwaters to some of the state's largest warm-water rivers. Many rivers and streams here support and provide high quality habitat for numerous Species of Greatest Conservation Need (SGCN). These include gilt darter (*Percina evides*), lake sturgeon (*Acipenser fulvescens*), longear sunfish (*Lepomis megalotis*), greater redhorse (*Moxostoma valenciennesi*), mink frog (*Rana septentrionalis*), pickerel frog (*Lithobates palustris*), mudpuppy (*Necturus maculosus*), wood turtle (*Glyptemys insculpta*), and water shrew (*Sorex palustris*). Several of these rivers and streams are candidates for designation as Conservation Opportunity Areas, including the upper East Fork of the Chippewa River (Ashland and Sawyer counties), upper West Fork of the Chippewa River (Ashland and Sawyer counties), North Fork of the Flambeau River (Ashland, Price, and Sawyer counties), South Fork of the Flambeau River (Price, Rush, and Sawyer counties), lower Flambeau River (Rusk County), Jump River (Price, Taylor, and Rusk counties), upper Wolf River (Forest, Oneida, and Langlade counties), Pine River (Forest and Florence counties), lower Popple River (Florence County), headwaters streams from the Blue Hills (Rusk County), and Moose Creek (Iron County) in the Winegar Moraines (WDNR 2008b). Four named streams sustain wild rice populations that are monitored by tribal authorities (GLIFWC 2003).

Forested watersheds are a critical factor in maintaining healthy stream environments because forest cover helps keep water temperatures cooler, prevents soil erosion and sedimentation, retains excess nutrients that could cause eutrophication if released, and minimizes extremes in runoff flows by retarding the downstream flow of precipitation. The extensive forest cover that is prevalent throughout much of the North Central Forest Ecological Landscape helps maintain the diversity of native aquatic organisms and water-dependent species in many of the larger streams. Water quality in upstream tributaries is high enough that it can help offset some downstream degradation, even in the reaches of streams that flow through and are impacted by agricultural land uses to the south of the North Central Forest.

Coldwater to coolwater streams in the North Central Forest Ecological Landscape include the upper reaches of the larger streams in this ecological landscape. They form the headwaters of Wisconsin's biologically most important rivers. These streams support a high diversity of aquatic organisms, due in part to the presences of a greater range of substrates



Rapids on the Jump River, a medium-sized stream with good water quality and a significant aquatic biota, that drains a forested watershed. Price County. Photo by W.A. Smith, Wisconsin DNR.



Little Falls on the Flambeau River. Eastern white pine is making a comeback in the second-growth northern hardwoods forest bordering the river. Flambeau River State Forest. Photo by Eric Epstein, Wisconsin DNR.

and gradients than is found further downstream and watersheds that are mostly forested, with generally low sediment and pollutant inputs. This diversity is important in maintaining the full range of ecological functions and nutrient cycling, making the biological productivity of these streams less vulnerable to the impacts of ecological disturbances. Often, multiple species of differing sensitivities to pollutants or temperature may be filling the same ecological roles, so that population crashes in one species from short-term reductions in water quality are offset by resilient populations of less vulnerable species. These aquatic organisms include insects, mollusks, fish, and amphibians that thrive in clean water with high oxygen levels and varied substrates (W.A. Smith, Wisconsin DNR, personal communication).

In the western lobe of the North Central Forest Ecological Landscape, high gradient, cold headwaters streams originate in the Penoque Range of Bayfield, Ashland, and Iron counties. These include Boomer, Fourche and Flood creeks (all in Iron County), Devils (Ashland County), and Tyler Forks

(Iron and Ashland counties) creeks, Spring Brook (Ashland County), and the headwaters of the Bad (Ashland County) and Potato (Ashland and Iron counties) rivers. These streams flow into major rivers, such as the Bad, Marengo (Ashland and Bayfield counties), and Montreal (Iron County), which in turn flow into Lake Superior. Rocky gorges and waterfalls at several locations provide habitat for rare species that do not occur elsewhere in the Lake Superior basin of Wisconsin (W.A. Smith, Wisconsin DNR personal communication).

High quality coldwater streams are also prevalent in western Sawyer, Rusk, and eastern Barron counties (including many streams coming out of the Blue Hills), and these add their flow to the upper Chippewa River. Some examples are the Brill (Barren and Washburn counties), Brunet and Couderay (both Sawyer County) rivers and Little Weirgor, Deer (both Rusk and Sawyer counties), Soft Maple and Hemlock (both Rusk County), Eddy and Venison (both Sawyer County), Hemlock (Rusk County), Cap (Bayfield County), Venison (Sawyer County), Spring Brook (Ashland County), and Price (Price and Sawyer counties) creeks.

In the eastern lobe of the North Central Forest Ecological Landscape, many of the abundant springs of northeastern Wisconsin contribute cold, clean, highly oxygenated water to some of highest quality coldwater and coolwater streams in that part of the state. Important coldwater streams here include Woods (Florence County), Lanon Tongue, Elvoy (Forest and Vilas counties), Wisconsin (Florence County), and Brule (Forest and Vilas counties) creeks; the upper tributaries of the Oconto River (Forest and Oconto counties); and the headwaters of the Peshtigo (Forest and Marinette counties), Brule (Florence County), and Pine rivers. In this area of the ecological landscape, the Pine and upper Popple rivers are small, fast streams with moderately swift currents and gravel substrates. The Pine River in particular hosts a rich assemblage of aquatic invertebrates that are very uncommon elsewhere in the state.

Historically, logging negatively impacted the physical attributes and biota of many of the larger rivers and streams in the North Central Forest (see the “Early Logging” section of this chapter). This occurred through the removal of forest cover, physically damaging the banks and shoreline vegetation, smothering river and stream substrates with bark and other debris during log drives, and lowering water quality. Toward the end of the logging era and for decades that followed, the pulp and paper industry discharged untreated effluent into some river segments, covering stream bottom habitats with sludge and creating zones of high **biological oxygen demand** (BOD) where many species could not survive. Cleanup required by federal clean water legislation since 1972 has resulted in significant improvements in water quality. In more recent times, poorly sited or constructed culverts and road crossings have been significant barriers to the movements of aquatic animals in stream corridors (Januchowski-Hartley et al. 2013). This situation is being addressed on a case-by-case basis in conjunction with maintenance projects.

Warmwater rivers and streams constitute major components of the aquatic environments in the North Central Forest. The dominant river in terms of both flow volume and ecological significance is the Chippewa River in the western part of the North Central Forest. The Chippewa River (especially the stretch that flows through Rusk County) supports the highest species richness for native aquatic invertebrates and fish of any river in this ecological landscape, making it comparable in that regard to other rivers and streams of high ecological significance around the state. The high diversity and abundance of pollution intolerant species reflects the overall good water quality and watershed conditions in the upper Chippewa system and the wide range of habitats present (W.A. Smith, Wisconsin DNR, personal communication). Other high quality warmwater streams in the western part of this ecological landscape are major tributaries of the Chippewa. These include the Flambeau (both the North and South Forks), Jump, and Thornapple rivers. This ecological landscape also contains the headwaters of the Black, Yellow, and Namekagon rivers.

The Flambeau River downstream from Park Falls is an example of a river that was negatively impacted by paper mill discharges (see the “Water Quality” section of this chapter). Since the 1970s, federal requirements of the Clean Water Act have promoted significant improvements in water quality. However, species richness is still often less in **river reaches** formerly impacted by industrial discharges compared to non-impacted reaches (W.A. Smith, Wisconsin DNR, personal communication). Some of the more pollution-intolerant species have still not been able to recolonize river reaches below sites where bottom substrate may hold discharged industrial wastes. Based on studies of reaches above and below discharge sites, some biologists suspect that even though present effluent discharges meet current standards, lingering effects of past discharges may be preventing the return of some of the more sensitive species.

Forests cover over 60% of the Thornapple watershed, which has little agriculture and no point source pollution discharges. Invertebrate surveys indicate this stream has very good water quality, and the Thornapple River has potential sturgeon spawning habitat.

The Jump River originates and flows through an area that is primarily forest and wetland. Although the upper reaches of its north and south forks are potentially impacted by a large cranberry operation and gravel operation, respectively, the Jump River is an **Exceptional Resource Water** stream. The Jump River is a biologically rich stream that supports rare and other sensitive aquatic species.

Forested ground moraine is prevalent in the headwaters of the Yellow River in Taylor County, but downstream the land becomes more agricultural. It supports a moderately diverse aquatic invertebrate community above Chequamegon Waters Flowage (Taylor County).

The headwaters of the Namekagon River (a major tributary to the St. Croix River) flow from Namekagon Lake. This keeps

the upper reaches of the Namekagon relatively warm, which promotes greater diversity of aquatic invertebrates. When the cold waters of Cap Creek (Bayfield County) enter the Namekagon near the boundary of the Northwest Sands Ecological Landscape, the Namekagon cools enough to support trout and other coolwater aquatic species but with less diversity in the invertebrate community than is found upstream. As a federal wild and scenic river, the St. Croix-Namekagon system is a major natural, recreational, and aesthetic resource.

In the eastern portion of this ecological landscape, rivers flow into Green Bay, and several exhibit excellent habitat diversity and overall very good water quality. These include the Peshtigo, Wolf, Oconto, Pine, and Popple rivers.

The Peshtigo River has the variety and extent of habitats, including bedrock and gravel substrates, a slower current, and temperature gradient from colder headwaters to warmer downstream waters, that are more characteristic of larger streams, similar to the Flambeau River farther west. The Peshtigo supports a high diversity of aquatic invertebrates, including eight species that are on the Wisconsin Natural Heritage Working List (WDNR 2009).

One of the most well-known streams in Wisconsin for river recreation, the upper Wolf River originates from Post Lake near Crandon in Forest County. This slightly stained stream has many small tributaries that have at times been heavily impacted by beaver dams (WDNR 2001a). It is a coolwater stream through the North Central Forest, with excellent aquatic community diversity amid a varied substrate of gravel, cobble, loose rock, and bedrock. Mussel species diversity here is notably lower than in the similarly sized Chippewa and Flambeau river reaches to the west (W.A. Smith, Wisconsin DNR, personal communication).

The only portion of the Oconto River within this ecological landscape is the North Branch of the Oconto River. This coolwater stream originates in a watershed that is composed of 86% forests and wetlands, and it is not affected by any point source or nonpoint source pollution.

The Pine River and its major tributary, the Popple River, are smaller streams emerging from forested watersheds and are characterized by faster currents over gravel substrates. The larger stream bed, higher flows, and more varied habitat of the Pine make it richer as a supporter of rare aquatic invertebrate species. The Pine River is free flowing in this ecological landscape.

Swamp Creek, in southern Forest County, stands out in large part because it was surveyed thoroughly during the environmental review of a proposed copper/zinc mine near Crandon in the late 1990s. It was found to have a moderately diverse fauna, and the extensive data collected on it highlighted the in-stream vegetation, which includes stands of wild rice. Swamp Creek widens at one point to form Rice Lake, which supports extensive wild rice beds that are both an important wildlife food source and a vital cultural resource to the people of the surrounding Mole Lake Reservation. Swamp Creek serves as a well-studied example of the type of lake

and associated wetland systems of ecological and cultural significance that formerly occurred in many parts of northern Wisconsin, including the North Central Forest.

Springs

There are approximately 800 mapped springs in the North Central Forest Ecological Landscape (Macholl 2007), the fourth highest number of springs of all ecological landscapes in the state. Springs are concentrated in the eastern part of this ecological landscape, especially in Florence, Forest, and Langlade counties. They are major sources of water for many high quality coldwater streams, especially in those three counties. Springs are much less common in the western part of the ecological landscape; as a result, coldwater (trout) streams are also less common there.

Relatively few springs and spring ponds have been examined in enough detail to fully document their physical or biological characteristics. Some do exhibit extensive marl deposition, which at some point can begin to fill in a spring pond bed and cause the pond to “age,” resulting in a decrease in biological productivity. However, because the coldwater fishery here is an important element in not only the ecology of this ecological landscape but also the economy, the North Central Forest rivals the Western Coulees and Ridges Ecological Landscape as the most important place for protecting spring flows.

On average, Wisconsin DNR fishery crews dredge organic sediments from one spring pond each year in the North Central Forest. Dredging is seen as a way to set back a decline in coldwater habitat values and is aimed at boosting populations of native brook trout (*Salvelinus fontinalis*). Removal of substantial layers of sediment, built up since the end of the Pleistocene Era, has been demonstrated to improve water inflow and oxygenation to spring ponds. Crews take care not to enlarge these ponds or disrupt the source of inflowing cold groundwater. They also leave about 20% of the pond area undisturbed to serve as a recolonization source for invertebrates and other aquatic flora and fauna (D. Seibel, Wisconsin DNR, personal communication). However, recovery can be variable (Carline and Brynildson 1977), and baselines are needed to enable a better assessment of dredging impacts on nontarget organisms and identify the sources of spring pond decline. A statewide system of benchmark sites for comparative and conservation purposes would be ideal.

Wetlands

According to the Wisconsin Wetlands Inventory (WDNR 2010c) and WISCLAND data (WDNR 1993), wetlands are abundant in the North Central Forest Ecological Landscape, comprising 23.3% of the total land area, or nearly 1,381,000 acres. Forested wetlands comprise over 812,000 acres of this wetland area, with an additional 413,000 acres in shrub wetlands and 61,700 acres in emergent/wet meadow (a broad Wisconsin Wetlands Inventory category that encompasses marsh, sedge meadow, bog, and fen communities).

The abundance, generally good condition, and high ecological values of wetlands in this ecological landscape makes the North Central Forest one of the most important areas in the state in which to manage and conserve wetlands and their associated natural features. Many of the wetlands here are embedded within extensive forest cover and also adjoin lakes and streams, and the magnitude of agricultural activities and other developments that have functionally disrupted and altered wetlands elsewhere in the state is comparatively low here.

Populations of invasive plants such as purple loosestrife, reed canary grass, common reed, and Eurasian water-milfoil (*Myriophyllum spicatum*) are more localized and not yet as widespread here as they are in many other parts of Wisconsin. The abundance of wetlands contributes to the high water quality found in much of this ecological landscape.

Forested wetlands are well represented in the North Central Forest. Acid conifer swamps dominated by black spruce and tamarack are widespread and common, and wet-mesic northern white-cedar swamps are better represented here than anywhere else in the state. Ash-dominated hardwood swamps are also quite common. Floodplain forests are uncommon to rare here, with the community and many of its constituent species reaching or nearing their northern range limits.

Wetlands dominated by tall shrubs include Alder Thicket and Shrub-carr. Alder Thicket is common and widespread throughout this ecological landscape, where it is found in wetland complexes along streams and lakeshores, and in some basins. On some sites, Alder Thicket occurs as a zone, between lowland forests and open wetlands. Shrub wetlands receiving more mineral-enriched groundwater or runoff may support Shrub-carr, but this community is more common south of the **Tension Zone**. (See the “Natural Communities” section of this chapter for more information.)



Kidrick Swamp is a vast acid peatland composed of *Sphagnum* mosses, *ericaceous shrubs*, sedges, and swamp conifers. The most abundant natural communities are Muskeg and Black Spruce Swamp. Medford District, Chequamegon-Nicolet National Forest, Taylor County. Photo by Drew Feldkirchner, Wisconsin DNR.

Peatlands featuring a sparse growth of stunted bog conifers, *ericaceous shrubs*, and a hummocky but continuous carpet of mosses are common in this ecological landscape. Natural communities associated with acid peatland complexes in the North Central Forest include Open Bog, Poor Fen, Muskeg, Black Spruce Swamp, and Tamarack Swamp. (See the “Natural Communities” section for more information.)

Herbaceous wetlands are widespread and include marsh, sedge meadow, and fen communities. All are important habitats for sensitive plants and animals. Wild rice marshes are more abundant and widespread here and in the Northern Highland Ecological Landscape than anywhere else in Wisconsin. Marshes, composed of emergent, submergent, and floating-leaved aquatic macrophytes occur in the shallow waters of protected bays and are sometimes present in low gradient rivers and streams of at least moderate fertility.

As noted in the “Inland Lakes” section above, the North Central Forest Ecological Landscape contains 150 “wild rice waters” documented by the Wisconsin DNR and tribal resource managers, far more than in any other ecological landscape. A majority of these waters are small unnamed streams, lakes, and wildlife flowages, while 54 are named water bodies (WDNR 2012c). Wild rice waters include natural lakes, slow-moving rivers and streams, and impoundments, such as the Chippewa Flowage, Turtle-Flambeau Flowage, Lac Courte Oreilles, and the upper Wolf River. These waters provide areas with depths close to the ideal range for wild rice of 1–3 feet, appropriate low flow velocities (slow, but not stagnant), good water quality with a minimum of turbidity, moderate or sometimes low fertility, and a silty to mucky bottom. Other prominent wild rice waters include Chippewa Lake and Totagatic Flowage (Bayfield County); Wabikon, Rice, Mole, and Little Rice lakes and Rat River (Forest County); Atkins Lake (Forest and Oneida counties); Swamp Creek (Langlade County); Big Lake (at The Thoroughfare), Round Lake and Pelican Lake (Oneida County); Lac Courte Oreilles, Blaisdell, and Nelson lakes (Sawyer County); Chequamegon Waters Flowage (Taylor County); and Tranus Lake and Long lakes (Washburn County). A number of these wild rice waters are being surveyed as part of a long-term monitoring project by the Great Lakes Indian Fish and Wildlife Commission (David 2012).

Ephemeral Ponds

Ephemeral ponds are common and widespread here. Compact till, silty soils, high water tables, and gentle terrain account for the prolonged periods of seasonal wetness, numerous small wetlands, and the abundance of ephemeral ponds characteristic of parts of this ecological landscape, including the Flambeau River State Forest. Ephemeral ponds occupy depressions with impeded drainage, usually within forested landscapes, that hold water for a period of time following snowmelt but typically dry out by mid-summer. Ephemeral ponds are free of fish and provide critical, secure breeding habitat for frogs, salamanders, and certain invertebrates (Anderson et al. 2008b).

Water Quality

A large majority of the watersheds surveyed here have good water quality and low vulnerability to nonpoint source pollution impacts when compared with most other ecological landscapes in Wisconsin (see Appendix 12.A at the end of this chapter). Factors contributing to high water quality here include extensive forest cover, limited urban, industrial, and agricultural development, the addition of cold, clean, oxygenated water from springs, and geological characteristics (topography, composition of the parent material, and soils) that affect water salinity, soluble material content, trace elements, and characteristics of bottom and suspended sediments. In many North Central Forest watersheds, agricultural land use covers less than 10% of total watershed area, so agricultural runoff is generally minor.

Past land uses damaged aquatic habitats, especially in rivers and streams, and diminished water quality. The widespread and intensive logging and associated log drives that took place from the 1850s to the 1920s resulted in higher surface water runoff rates, higher peak flows, less shading, created siltier, warmer streams, added sediments to lakes, and altered stream hydrology. Massive log drives resulted in streambank damage, and the subsequent deposition of tree bark into the stream and lake waters caused reduced oxygen levels as the bark decomposed. More recently, energy demands for wood pulping and other industries prompted construction of large hydroelectric dams. Wood pulping also led to the discharge of mill sludge, mercury, and other contaminants into a number of rivers and impoundments.

Efforts to farm following the Cutover were short-lived in most areas. Forest regeneration since the 1930s as well as pollution-control programs since the 1970s has helped to improve shoreline and aquatic habitats and water quality. Improvements in some waters have been dramatic compared to conditions during the period of greatest degradation (WDNR 2001b).

Historically, the water quality in the North Fork of the Flambeau River had been severely impaired by poorly treated and untreated waste discharges from municipal and industrial sources in the city of Park Falls. Various accounts from the late 1920s through 1980 documented the adverse effects of discharges from a pulp and paper mill and sewage treatment plant in Park Falls on water quality, fish, benthic fauna, in-stream and reservoir habitat, and aquatic vegetation. Specific impacts included extensive fish kills, high biological and chemical oxygen demand, fungal and slime growth, high fecal coliform counts, mercury contamination (WDNR 1996), and extensive deposition of wood fibers and other wastes from paper and lumber manufacturing that tend to accumulate on the stream bed. The aquatic ecosystem was limited to tolerant organisms that are characteristic of polluted conditions.

During the same period, water quality in the lower Flambeau River downstream from the confluence of the North and South Forks to its mouth at the Chippewa River was notably better than in the reach of the North Fork below the pollutant

discharges at Park Falls. Water quality improvements in the lower Flambeau River were attributed to the influx of high water quality from the South Fork of the Flambeau River. Improved treatment of municipal and industrial wastewater has helped improve conditions in the North Fork of the Flambeau since the 1980s.

The percentage of lakes with “Good” or “Excellent” water quality, as measured by the *trophic state* index (TSI), is higher here than in any other ecological landscape except for the Northern Highland, based on an analysis of Landsat satellite remote sensing imagery (Greb et al. 2009). The deep headwaters seepage lakes tend to feature the highest water quality. The TSI derived from satellite imagery provides an approximation of the degree of eutrophication that individual lakes exhibit and is correlated to citizen monitoring records of *Secchi disk* readings.

Many lakes in this ecological landscape, including lakes Namekagon, Nelson, and the Eau Claire Lakes chain, are ranked high in their vulnerability to nonpoint source pollution. In northern Chippewa County, Axehandle (Chippewa County), Bradley (Forest County), Pine, the Island Chain (Rusk County), and other lakes are likewise potentially vulnerable to nonpoint impacts. High levels of shoreline development, permeable soils, and a lack of natural pH buffering contribute to this ranking.

Outstanding Resource Waters (ORW) or *Exceptional Resource Waters* (ERW) are surface waters that have good water quality, support valuable fisheries and wildlife habitat, provide outstanding recreational opportunities, and are not significantly impacted by human activities. Waters with ORW or ERW status warrant additional protection from the effects of pollution. Both designations have regulatory restrictions, with ORWs being the most restricted. These designations are intended to meet federal Clean Water Act obligations and prevent any lowering of water quality or degrading of aquatic habitats in these waters. They are also used to guide land use changes and human activities near these waters. A complete list of ORWs and ERWs in the North Central Forest Ecological Landscape can be found on the Wisconsin DNR website (WDNR 2012b).

Waters designated as impaired on the *U.S. Environmental Protection Agency (EPA) 303(d) list* exhibit various water quality problems including *polychlorinated biphenyls* (PCBs) in fish, sediments contaminated with industrial metals, mercury from atmospheric deposition, bacteria from farm and urban runoff, and habitat degradation. A plan is required by the EPA on how 303(d) designated waters will be improved by the Wisconsin DNR. This designation is used as the basis for obtaining federal funding, planning aquatic management work, and meeting federal water quality regulations. Since the 303(d) designation is based on the numeric water quality criteria included in Chapters NR 102–105, Wisconsin Administrative Code, Wisconsin DNR technical documents, narrative standards, and federal guidance, a waterbody could be listed as a 303(d) water as well as an

ORW or ERW (see the “Aquatic Communities” section in Chapter 2, “Assessment of Current Conditions,” for more information on water quality standards).

Several dozen North Central Forest lakes and impoundments and a few rivers are classified as 303(d) impaired waters, in all cases due to atmospheric deposition of mercury, with additional impairments in a few of these water bodies. Elemental mercury undergoes methylation through microbial processes to become bioavailable and concentrates up the food chain in fish tissues. The degree of methylation, and thus bioavailability in fish tissue, is generally higher in reservoirs and drainage lakes due to their higher sediment loading. Sediment tends to support sulfur-reducing bacteria that often drive the methylation process. Higher levels of acidification (lower pH) associated with waters influenced by bogs and certain other wetlands also contribute to methylation and greater bioavailability of mercury (Scudder et al. 2009, USGS 2009). Monitoring has shown that a number of reservoirs have mercury contaminated sediments, including Pixley Flowage (Price County) on the upper North Fork of the Flambeau River, Flambeau Flowage, and Sailor Creek Flowage and Musser Flowage (both in Price County).

Impaired natural lakes in the North Central Forest include Butternut, Roberts, Silver, and Arbutus (in Forest County); Moose, Ghost, Spider, Windigo, Mud, Winter, Fishtrap, Loretta, and Callahan (in Sawyer County); Diamond (in Bayfield County); Mineral, Gallilee, Bear, Day, and English (in Ashland County); Willow (in Oneida County); and Solberg (in Price County) in the western portion of the ecological landscape. In the eastern part of the ecological landscape, lakes that are impaired include Van Zile (in Forest and Florence counties.); Deep Hole and Little Sand (in Forest County); and Greater Bass, Summit, Lower Bass, Clear, and Deep Wood (in Langlade County). Impairment in these lakes is also due to high concentrations of mercury in fish tissue.

Relatively few rivers in this ecological landscape are 303(d) impaired. The Chippewa River segment in the Weirgor Creek watershed is impaired due to atmospheric mercury accumulation in sediments, while a reach of the Wisconsin River below Tomahawk is impaired due to high biochemical oxygen demand, a high sediment load, and sedimental mercury. The complete list of 303(d) impaired waters and criteria can be viewed at the Wisconsin DNR’s impaired waters web page (WDNR 2010b).

Biotic Environment

Vegetation and Land Cover

Historical Vegetation

Several sources were used to characterize the historical vegetation of the North Central Forest, relying heavily on data from the federal General Land Office’s public land survey (PLS), conducted in Wisconsin between 1832 and 1866 (Schulte and Mladenoff 2001). PLS data are useful for providing estimates of forest composition and tree species dominance for large

areas (Manies and Mladenoff 2000). Finley’s map of historical land cover based on his interpretation of PLS data was also consulted (Finley 1976). Additional inferences about vegetative cover were sometimes drawn from information on land capability, climate, disturbance regimes, the activities of native peoples, and from various descriptive narratives. More information about these data sources is available in Appendix C, “Data Sources Used in the Book,” in Part 3, “Supporting Materials.” According to Finley’s map and data interpretation (Finley 1976), the North Central Forest Ecological Landscape of the mid-1800s contained Wisconsin’s most extensive area of contiguous Hemlock-Yellow Birch-Sugar Maple-Pine Forest (“Northern Mesic Forest”), with 69% of the ecological landscape forested with hemlock-hardwood or northern hardwood forests (Figure 12.4). Swamp conifers were the next most abundant type, making up 18% of the area with the remaining types each comprising 5% or less of the ecological landscape. There was little open habitat according to Finley’s interpretation. See the map entitled “Vegetation of the North Central Forest in the Mid-1800s” in Appendix 12.K.

The PLS information has been converted to a database format, and importance values for tree species were calculated based on the average of tree species density and *basal area* (He et al. 2000). Based on this analysis, eastern hemlock (22% of the relative importance value, or RIV) and yellow birch (18% of the RIV) dominated the mix of tree species, exhibiting the highest RIVs for these species of any ecological landscape. Other “northern hardwoods” species recorded in the North Central Forest Ecological Landscape included sugar maple (13.8% of RIV), white ash (3.6% of RIV) and American basswood (2.1% of RIV). Eastern white pine was an important species in this ecological landscape (11.7% of RIV), while red pine (1.7% of RIV), jack pine (*Pinus banksiana*) (0.3% of RIV), and oaks (*Quercus* spp.) (1.4% of RIV) were much less important. Tamarack (8.1% of RIV) and northern white-cedar (4.5% of RIV) had higher RIVs here than in most other ecological landscapes. See the map “Vegetation of the North Central Forest in the Mid-1800s” in Appendix 12.K.

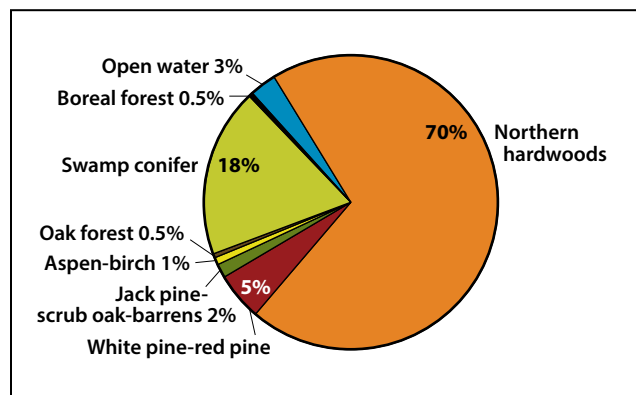


Figure 12.4. Vegetation of the North Central Forest Ecological Landscape during the mid-1800s, as interpreted by Finley (1976) from the federal General Land Office’s public land survey information.

Current Vegetation

There are several data sets available to help assess current vegetation on a broad scale in Wisconsin. Each was developed for different purposes and has its own strengths and limitations in describing vegetation. For the most part, WISCLAND, the Wisconsin Wetlands Inventory (WWI), the U.S. Forest Service's Forest Inventory and Analysis (FIA), and the National Land Cover Database (NLCD) were used. Results among these data sets often differ as they are the products of different methodologies for classifying land cover, and each data set was compiled based on sampling or imagery collected in different years, sometimes at different seasons, and at different scales. In general, information was cited from the data sets deemed most appropriate for the specific factor being discussed. Information on data source methodologies, strengths, and limitations is provided in Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials." WISCLAND land use/land cover data (WDNR 1993) classifies general land cover attributes and can be useful in characterizing large-scale land use features. It is based on satellite imagery from 1992, so it does not represent present-day information. We use it here to offer a general view of land use and land cover in this ecological landscape.

The North Central Forest Ecological Landscape is approximately 6,107,000 acres (the second largest of Wisconsin's 16 ecological landscapes), of which over 73% was forested in 1992 (WDNR 1993). Over 28% of Wisconsin's forested lands are found within this ecological landscape. With more than 4,400,000 forested acres, the North Central Forest has by far the most forested acreage of any ecological landscape (the Western Coulees and Ridges is second with approximately 2,600,000 forested acres). WISCLAND land use/land cover data from 1992 also indicates that 23% of the ecological landscape was nonforested, and 4% was open water (Figure 12.5). Nonforested areas were mostly open or shrub-dominated wetlands, with a small amount of grassland, upland brush, and agricultural cropland. Urban areas made up less than 1%.

According to the Wisconsin Wetlands Inventory (WDNR 2010c), the extensive wetlands in the North Central Forest comprise a significant portion (23%) of vegetation here (this does not include the area covered by lakes). Forested wetlands make up over 811,000 acres of the ecological landscape, making these the most abundant wetlands in the North Central Forest. Approximately 54% of the forested wetlands are coniferous, and approximately 45% are deciduous hardwoods. Shrub/scrub wetlands occur across more than 413,000 acres. Wet meadows (including emergent marsh and open bog) occupy nearly 61,000 acres. The margins of lakes, streams, and springs support 5,400 acres of aquatic bed wetlands. Approximately 89,000 acres of delineated wetlands included in the total acreage have not yet been classified by type. Additional information on wetlands and wetland flora may be found in the "Natural Communities" and "Flora" sections of this chapter and in Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin."

According to FIA data summarized in 2004, approximately 19% of the land area in the North Central Forest Ecological Landscape is nonforested, and about 81% is forested (USFS 2004). The predominant forest *cover type* group is northern hardwoods (47% of the forested area), followed by aspen-birch (24%), fir-spruce (8%), and lowland hardwoods (6%) (Figure 12.6). (Note that almost all of the "fir-spruce" here is lowland forest, not upland "boreal" types.) All other forest types occupy 5% or less of the forested area.

Changes in Vegetation over Time

The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities now altered in number, size, or extent or that have been changed functionally (for example, by dam construction or fire suppression). Although data are limited to a specific snapshot in time, they provide valuable insights into Wisconsin's ecological capabilities. Maintaining or restoring some lands to more closely resemble historical systems and including some structural, compositional, and functional components of the historical landscape within actively managed lands can help conserve important elements of biological diversity. It is part of

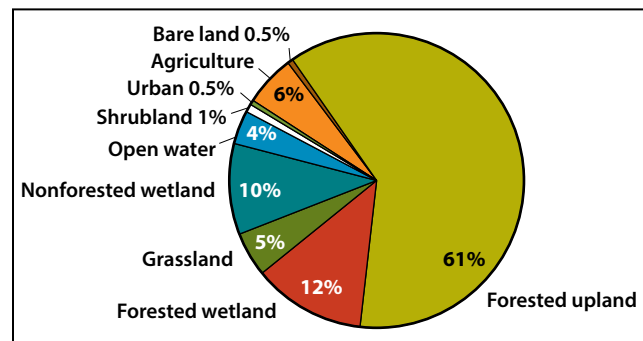


Figure 12.5. WISCLAND land use/land cover data showing categories of land use classified from 1992 LANDSAT satellite imagery for the North Central Forest Ecological Landscape (WDNR 1993).

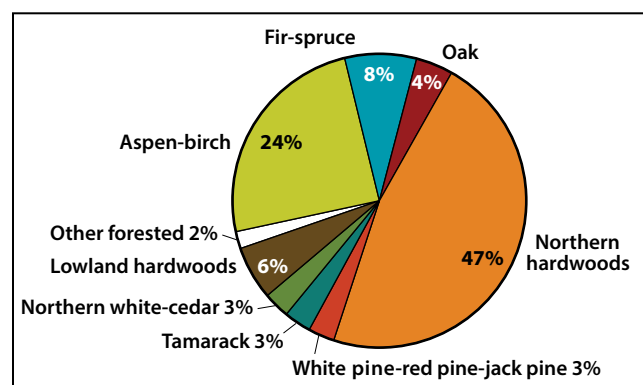


Figure 12.6. Forest Inventory and Analysis data (USFS 2004) showing forest type as a percentage of forested land area (greater than 17% crown cover) for the North Central Forest Ecological Landscape. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the FIA data.

the intent of this publication to identify those ecological landscapes in which such efforts might be focused and conducted most effectively. However, we do not mean to imply that entire ecological landscapes should be restored to their historical conditions as this is neither feasible nor necessarily desirable within the context of providing for human needs and desires.

Current forest vegetation (based on FIA) is primarily northern hardwoods (37%), aspen-birch (16%), and red maple (14%) (Figure 12.7). Aspen (*Populus* spp.) has increased by almost three times from historical

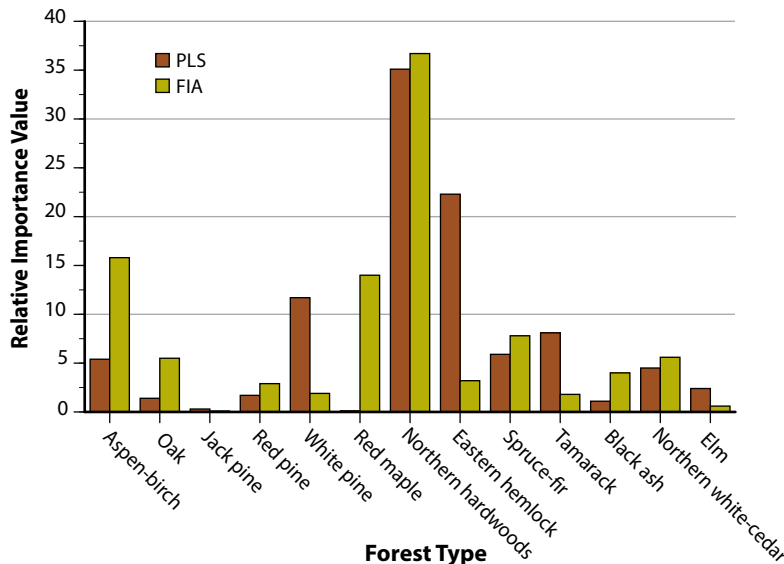


Figure 12.7. Comparison of tree species' relative importance value (average of relative dominance and relative density) for the North Central Forest Ecological Landscape during the mid-1800s, when the federal General Land Office public land survey (PLS) data were collected, with 2004 estimates from Forest Inventory and Analysis (FIA) data (USFS 2004). Each bar represents the proportion of that forest type in the data set (totals equal 100). Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.

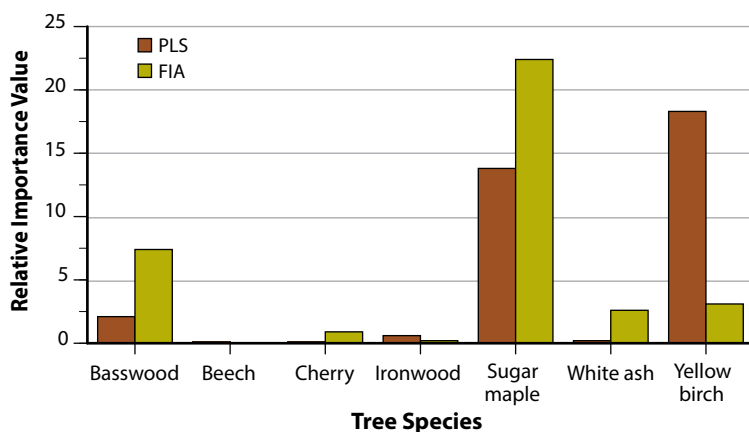


Figure 12.8. Changes in "northern hardwoods" tree species' relative importance value (average of relative dominance and relative density) over the last 150 years, using federal General Land Office public land survey (PLS) data from the mid-1800s and Forest Inventory and Analysis (FIA) data from 2004. Trees of less than 6-inch diameter were excluded from the FIA data set to make it more comparable with PLS data. See Appendix C, "Data Sources Used in the Book," in Part 3, "Supporting Materials," for more information about the PLS and FIA data.

conditions (5.4% to 15.8%), while red maple has increased exponentially (from 0.1% to 14.0%). Eastern hemlock, yellow birch, and eastern white pine have all decreased substantially to approximately one-sixth of their historical levels, with eastern hemlock decreasing from 22.3% to 3.2%, yellow birch from 18.3% to 3.1%, and eastern white pine from 11.7% to 1.9%.

Based on RIV, the abundance of northern hardwood species, as a group, has not changed a great deal over time, but the composition of these forests has changed dramatically (Figure 12.8). Sugar maple RIV has increased by 9% and American basswood by 5%, although yellow birch has declined by 15%. Combined with the decline of eastern hemlock and eastern white pine, once widespread and common components of northern hardwood stands, the forested *matrix* of this ecological landscape has changed greatly in composition, structure, and function over the last 150 years. The increases in red and sugar maple reflect the often described "maple-ization" of Wisconsin and other Lake States hardwood forests and is the result of past land use practices in this ecological landscape.

Natural Communities

This section summarizes the abundance and importance of major physiognomic (structural) natural community groups in this ecological landscape. Some of the exceptional opportunities, needs, and actions associated with these groups, or with some of the individual natural communities, are discussed briefly. For details on the composition, structure, and distribution of the specific natural communities found in the North Central Forest, see Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin." Information on invasive species can be found in the "Natural and Human Disturbances" section of this chapter.

Forests. The prevalent plant community in this ecological landscape is Northern Mesic Forest, also referred to as northern hardwoods forest or hemlock-hardwoods forest, depending on canopy dominants. Conceptually, the Northern Mesic Forest community is very broad because it may encompass stands of pure eastern hemlock, eastern hemlock mixed with eastern white pine, eastern hemlock mixed with varying amounts of hardwoods, and pure hardwoods. Besides variability in cover type, which can be the temporary result of disturbance history rather than an expression of intrinsic stand-level factors, sites

supporting “Northern Mesic Forest” may differ significantly in soil texture, nutrient levels, type of humus, understory composition, landform, *ecological context*, and site potential. The animal assemblages associated with different cover types, successional stages, and developmental stages can also differ greatly. It would be useful to split the Northern Mesic Forest into several related but distinct communities to ensure that the full natural range of compositional and structural variability is captured when “Northern Mesic Forests” are protected and managed for conservation purposes. See Kost et al. (2007) for additional information.

While the details can be critical for biodiversity purposes when defining the differences among mesic forests, what can be lost in the descriptions of all this variability is the overall significance the extent and abundance of the northern mesic forests—especially in the North Central Forest—have for native plants and animals, soil productivity, carbon sequestration, water quality, and entire watersheds.

Stands disturbed by heavy logging during the Cutover, especially when this was followed by slash fires, may now be dominated by aspens (mostly trembling aspen, big-tooth

aspen [*Populus grandidentata*] to a much less degree), white birch (*Betula papyrifera*), or even-aged hardwoods. Even in the latter case, these forests bear little resemblance to their condition prior to the Cutover. Note that Northern Mesic Forest is not a fire-adapted natural community—the fires that burned so much of this type in northern Wisconsin, as elsewhere—were the result of either carelessness or deliberate attempts to destroy the forest and transform the land into something approximating suitability for future agricultural endeavors. Medium-aged and young stands of Northern Mesic Forest are now prevalent throughout northern Wisconsin, and aspen is now a major cover type.

Stands disturbed by destructive or unsustainable logging practices, such as the logging associated with the Cutover of the late 19th and early 20th centuries, often lost characteristic canopy species such as eastern hemlock and eastern white pine. The recovery of many of these stands, when compared to their composition and structure prior to logging, has still not occurred even a century or more after this event. Severe fire, which was rare and infrequent in mesic forests (WDNR 2006a), often accompanied or followed logging as it was practiced during the Cutover. Excessive browse pressure from white-tailed deer (*Odocoileus virginianus*) and infestations of nonnative earthworms (family Lumbricidae), pathogens, or invasive plants may not only contribute to but exacerbate



Rich mesic hardwood forests may support diverse assemblages of spring wildflowers. Plants pictured here include wild leek (*Allium tricoccum*), cut-leaved toothwort (*Cardamine concatenata*), Virginia waterleaf (*Hydrophyllum virginianum*), large-flowered bellwort (*Uvularia grandiflora*), spring-beauty (*Claytonia virginica*) and dwarf ginseng (*Panax trifolius*). Photo by Drew Feldkirchner, Wisconsin DNR.



Interior of old-growth hemlock-hardwood forest. Vilas County. Photo by Eric Epstein, Wisconsin DNR.

past losses. These are among the factors responsible for the decline of many of our more specialized and sensitive native understory plants and their replacement by widespread habitat generalists (Rooney et al. 2004).

Lowland forests are common in poorly drained basins and also occur along the edges of lakes and streams. The best statewide representation of Northern Wet-mesic Forest (a broad forest classification category that encompasses both conifer-dominated northern white-cedar swamps and black ash-dominated [*Fraxinus nigra*] northern hardwood swamp) by acreage is in this ecological landscape. Northern white-cedar swamps are floristically diverse and are of especially high value to rare plants. Both northern white-cedar and black ash swamps are very sensitive to hydrologic disruption. Northern white-cedar, the dominant tree of the northern white-cedar swamps, is suffering almost total reproductive failure across its Wisconsin range due to excessive white-tailed deer browse. Black ash swamps sometimes occur in nearly monotypic stands and should be regarded as highly threatened by the exotic emerald ash borer (*Agrilus planipennis*).

Relatively minor occurrences of Floodplain Forest are found along several of the North Central Forest's larger rivers,

and though stands of this community in northern Wisconsin tend to be small, linear, and depauperate, they can provide important forested corridors that aid in the dispersal of animals as well as suitable conditions for organisms that do not occur in or are scarce in other habitats.

Acid conifer swamps (formerly Northern Wet Forest) include Black Spruce Swamp and Tamarack (poor) Swamp and are broadly distributed and common in the North Central Forest, where they often co-occur with other acid peatland communities such as Muskeg, Open Bog, and Poor Fen.

Old-growth mesic forest was abundant historically in the North Central Forest, where it had been the dominant vegetation for several millennia, making up 50% or more of the mesic forest cover (WDNR 2006a). **Old-growth forest** is now extremely rare in Wisconsin, comprising at best only a few one-hundredths of 1% of forest cover (Frelich 1995). Paradoxically, eastern hemlock-dominated stands are now better represented in reserved areas such as state natural areas or federal **research natural areas** than hardwood-dominated stands. This was due to the initial interest and focus of conservationists on eastern hemlock, which, because of the tremendous decline it had experienced throughout its state range, had gone from being a northern forest canopy dominant to a species that was quite rare. The relative lack of interest in hardwoods also occurred because the "Northern Mesic Forest" type has been so broadly drawn here that some of the significant variability associated with the northern hardwoods was either not recognized or was given scant attention by the conservation community. None of the current reserves cover more than a few hundred acres, and most are much smaller than that. Such small reserves can be heavily influenced by activities on adjacent lands and are also vulnerable to catastrophic damage due to natural disturbance events such as wind or ice storms that can affect entire stands. Recovery of these stands to their previous condition is problematic because of the context within which the reserved



Vigorous eastern hemlock reproduction under deciduous pole timber is unusual across most of northern Wisconsin. Penoque Range, Iron County. Photo by Eric Epstein, Wisconsin DNR.



Remnant stand of old-growth Northern Mesic Forest dominated by eastern hemlock. Formerly abundant, such forests are now very rare in Wisconsin. Tucker Lake Hemlocks, Chequamegon-Nicolet National Forest, Price County. Photo by Eric Epstein, Wisconsin DNR.

stands now occur (where conditions may have been greatly altered) and some of the negative edge impacts.

There is a critical need to protect remaining stands exhibiting old-growth characteristics and to manage some forests in the north toward the goal of restoring those missing old-growth structural and compositional attributes. For additional information on why old growth is important, see the Wisconsin DNR's *Old-Growth and Old Forests Handbook* (WDNR 2006a). The chapter on "Northern Hardwoods" provides specific guidelines for including old-growth and **old forest** considerations into active management plans in "working forests."

■ **Savannas.** No occurrences of either oak or pine savanna communities have been documented in the North Central Forest, nor were any recorded in the notes of the surveyors engaged in the federal public land survey of the mid-19th century. Climate, landforms, soils, historical and current vegetation, and dominant disturbance regimes make this ecological landscape almost entirely unsuitable for the conservation and management of savannas.

■ **Shrub Communities.** Alder Thicket is a widespread and common shrub-dominated wetland community found along lakeshores, streams, and sometimes as a distinct vegetation zone in wetland complexes where it may separate herbaceous wetlands from lowland forests. All shrub swamps are best conserved by protecting and maintaining site hydrology and managing them as integral components of interacting wetland **mosaics** that may include lowland forests, open wetlands, and aquatic features.

Shrub swamps composed of bog birch (*Betula pumila*), chokeberry (*Aronia melanocarpa*), common winterberry (*Ilex verticillata*), and mountain holly (*Ilex mucronata*) also exist in the North Central Forest Ecological Landscape and can occupy a distinct zone ringing the margins of basins containing boggy peatland communities. The interiors of the acid peatlands support continuous carpets of peat-forming sphagnum mosses (*Sphagnum* spp.) but often support high cover of ericaceous shrubs, such as leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), and cranberries. A component of stunted, scattered black spruce and tamarack may be present, forming a "Muskeg," characterized by sparse, spindly, small trees.

Shrub wetlands receiving more mineral-enriched groundwater may support "Shrub-carr," a community of generally more southern distribution in which willows (*Salix* spp.) and dogwoods (*Cornus* spp.) are the dominant tall shrubs. Where the hydrology is suitable, recently drained beaver impoundments may support thickets of willow-dogwood. Ultimately these may succeed to lowland forests.

■ **Herbaceous Communities.** The vast majority of herb-dominated natural communities in the North Central Forest are wetlands. Sedge meadows and marshes occupy basins and

shoreline areas that are influenced by mineral-enriched groundwater. Where the groundwater is relatively rich in calcium carbonates and the pH is high, northern ("boreal") fens may occur. "Poor Fens" are characterized by carpets of sphagnum ("peat") mosses, which are often continuous or nearly so and may float above the underlying groundwater. Sedges and other graminoid plants, low ericaceous shrubs, orchids, and insectivorous plants grow upon the moss substrate. (The term "poor" in this context refers to relatively low nutrient availability, not vascular plant diversity or economic values). "Rich" fens are dominated by moss genera other than *Sphagnum*, and the environments are more alkaline. Open Bog and Muskeg are acidic peatland communities of low pH in which mosses of the genus *Sphagnum* are the real dominants.

Protection and maintenance of site hydrology is the key management consideration for herbaceous wetlands, which need periodic monitoring to document the presence and extent of invasive plants or indicators of functional disruption, such as increases in woody cover that may come at the expense of the herbs. In general, protection and management are best achieved when treating these wetlands as integral components of a dynamic complex. Conversion of sedge meadows to waterfowl impoundments has been common in some areas. In the future, this should be preceded by careful assessment of the amount of such conversion that has already occurred in the ecological landscape as well as a clearer understanding of the impacts of losing additional sedge meadow habitat. Northern fens are highly sensitive to changes in groundwater chemistry and quantity, often support rare species, and should be managed and maintained, not converted to other vegetation types that are already common and possibly increasing and that do not support the more sensitive wetland inhabitants.

Herb-dominated uplands are limited to rocky exposures such as balds or bedrock glades (e.g., in the Penokee-Gogebic Iron Range), frost pockets (dry depressions, often in outwash



Spread Lake features a floristically rich open wetland and stands of swamp conifers embedded within an extensive area of managed northern hardwoods and aspen forest. Northern Vilas County. Photo by Eric Epstein, Wisconsin DNR.

sand landforms, in which growing season frosts can occur), and, very rarely, to linear patches of prairie vegetation, which have been reported by Fields (2003) and others from a few locations along railroad rights-of-way or sandy riverbanks at the extreme southern edge of the North Central Forest.

Farms occur in the North Central Forest and provide open habitats that are otherwise scarce in this part of Wisconsin. The bulk of the benefits seem to accrue to species that are already widespread and, in some cases, abundant from a state-wide perspective. Exceptions include several of our native grassland species, most of which can be more effectively and economically managed in other ecological landscapes. The costs of creating, maintaining, or purchasing open upland habitats in the North Central Forest should be weighed carefully against the benefits of managing and emphasizing such habitats elsewhere, where success for a larger number of species associated with or dependent on open habitats is more likely, the actions will be more cost effective, and some of the rarest obligate grassland species are much more likely to find their habitat needs met. The fragmentation of forested habitats by the maintenance of artificial openings can be a significant problem in some areas, especially where excessive white-tailed deer browse is occurring.

■ **Miscellaneous Communities.** Cliffs, glades, and *talus slopes* are geological features that provide habitat for certain plants and animals, including some that are highly specialized. Because this ecological landscape is almost entirely covered by glacial drift, bedrock exposures are rare and of limited extent. The Penokee Range, in the northwestern part of the North

Central Forest, features deep gorges cut by the Brunsweiler, Marengo, and Bad rivers and several of their tributaries. The Blue Hills, a quartzite range on the western edge of the North Central Forest, exhibits excellent examples of felsenmeer ("Sea of Rocks"), spectacular steep slopes of shattered rock (quartzite, in this case) that support unusual assemblages of lichens and rare vascular plants (several of the latter are disjunct from their more northerly ranges). To the east in the Nicolet National Forest, there are cliffs bordering the Brule River in Florence County and a striking quartzite outcropping, McCaslin Mountain, that straddles the Forest-Marquette county line. Bedrock habitats in each of the areas mentioned above support rare plants, and the unusual microhabitats provided by the rock exposures may also support rare animals, especially invertebrates. Abandoned mines in the Penokee Range support important populations of bats.

Forest Habitat Types

The North Central Forest Ecological Landscape is dominated by three habitat type groups: mesic, mesic to wet-mesic, and wet-mesic to wet (Table 12.2). Dry-mesic and dry sites are minor to rare within this ecological landscape.

Mesic sites are typically associated with loamy soils that are well to moderately well drained, and nutrient medium to rich. Currently, sugar maple is the dominant tree species in many stands, although many other hardwoods and conifers occur, typically as associates. Aspen is another common overstory dominant; however, succession to maple is well advanced in many stands. Potential late-successional dominants are sugar maple, eastern hemlock, and yellow birch.

Table 12.2. Forest habitat type groups and forest habitat types of the North Central Forest Ecological Landscape (NCF EL).

Northern forest habitat type groups common within the NCF EL ^b	Northern forest habitat types ^a common within the NCF EL ^b	Northern forest habitat types minor within the NCF EL ^b
Mesic (M)	ATM ATD AOCa	AH AAt ACaCi
Mesic to wet-mesic (M-WM)	TMC ArAbCo	ACal AHI ASal ArAbVC
Wet-mesic to wet (WM-W)	Forest Lowland (habitat types not defined)	
Northern forest habitat type groups minor within the NCF EL		
Dry-mesic (DM)		AVVb AVDe
Dry to dry-mesic (D-DM)		PARVAa PARVAm

Source: Kotar et al. (2002).

^aForest habitat types are explained in Appendix 12.B ("Forest Habitat Types in the North Central Forest Ecological Landscape") at the end of this chapter.

^bGroups listed in order from most to least common:

Common occurrence is an estimated 10–50% of forested land area.

Minor occurrence is an estimated 1–9% of forested land area.

Present – Other habitat types can occur locally, but each represents < 1% of the forested land area of the ecological landscape.

Mesic to wet-mesic sites are typically associated with loamy soils that are somewhat poorly drained and nutrient medium to rich. Currently, the most common overstory dominants are aspen and red maple; white birch is a common associate. Hardwood-dominated overstories are common, often composed of some mix of maples, ashes, American basswood, yellow birch, and eastern hemlock. Conifer dominated stands also are common, particularly on nutrient medium sites, and frequently dominated by a mixture of balsam fir, white spruce, eastern white pine, northern white-cedar, and red maple. Potential late-successional dominants are eastern hemlock, balsam fir, red maple, and sugar maple, accompanied by yellow birch, ashes, and American basswood.

Wet-mesic to wet forested lowlands typically occur on poorly drained peat and muck soils. On nutrient poor to medium sites, most stands are dominated by swamp conifers. On nutrient medium to rich sites, stands may be dominated by swamp conifers or swamp hardwoods.

For more information regarding the forest habitat type classifications, see Appendix 12.B at the end of this chapter.

Flora

The most comprehensive source of information on plant communities and flora of the North Central Forest Ecological Landscape is still *The Vegetation of Wisconsin* (Curtis 1959). While no single vegetation study has encompassed the breadth of the work conducted by Curtis, his faculty associates, and his students in the 1940s and 1950s, several recent papers provide especially useful references more specific to the North Central Forest. Fields (2003) described and documented the flora of Taylor County (at the southwestern edge of the North Central Forest Ecological Landscape) in great detail. He collected or examined specimens of 1,026 vascular plant species from that county between 1993 and 1997. Two hundred and twenty-two of these species (over 20%) had been introduced since settlement of the area by Euro-Americans. Other studies of the North Central Forest's flora have been more specialized or localized, focusing on sites, specific habitats, certain plant groups or species, or discrete properties. An example of the latter is Judziewicz's detailed survey of rare plants in the Nicolet National Forest (Judziewicz 1983).

Special mention must be made of *The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife* (Waller and Rooney 2008), which contains information on some of the dramatic changes to Wisconsin's vegetation and waters since Euro-American settlement. This book presents work that revisits many of the Curtis sites used as the basis for describing the state's plant cover and flora in *The Vegetation of Wisconsin* (Curtis 1959) and documents the changes that have occurred to many of our natural communities, including the northern forests, over the past 50 years.

The rare plant database of Wisconsin Natural Heritage Working List (WDNR 2009) tracks 95 rare vascular plant species that have been documented within the North Central

Significant Flora in the North Central Forest Ecological Landscape

- All natural communities have the potential to support rare plants, but not all of these habitats are of equal importance to rare plant species.
- Northern Mesic Forest, the most abundant community here, also supports the largest number of rare plant species.
- Among other widespread plant communities, many rare plants are associated primarily with wet-mesic forests, especially northern white-cedar swamps.
- Within a given natural community type, not all stands have equal potential to support rare or otherwise sensitive plant species.
- Uncommon or minor habitats of high significance to rare plants include bedrock exposures (cliffs and glades), beaches and other shoreline communities, and the northern fens.
- Lakes, streams, spring ponds, and seepages are important habitats for rare plants restricted to aquatic environments.
- Serious threats to the native flora of the North Central Forest include excessive browse pressure from white-tailed deer, altered soil structure by nonnative earthworms, and the rapid spread and increase in abundance of invasive plant species.
- Plants of northern regions that reach their southern range limits in northern Wisconsin may be especially vulnerable to climate change. A subset of these species and the communities to which they belong are candidates for long-term monitoring.
- Over the past half century, there has been a general decline in habitat specialists and liliaceous species and an increase in habitat generalists, *graminoids*, and exotic plants.

Forest. Among these 95 species, the State of Wisconsin lists 15 as endangered, 15 as threatened, and 65 as special concern. One species, the Wisconsin Endangered Fasset's locoweed (*Oxytropis campestris* var. *chartacea*), is listed as U.S. Threatened by the U.S. Fish and Wildlife Service.

Appendix 12.C at the end of this chapter lists all of the 95 rare plant species known to have extant populations (*element occurrences*) in the North Central Forest and also presents the number of occurrences of those 95 rare plant species in this ecological landscape, compared with the number of occurrences of these species for the entire state of Wisconsin. Information on state and global species ranks and legal status of each of these plants is also included in Appendix 12.C. Six of the 95 plant species on the Wisconsin Natural Heritage Working List that occur in the North Central Forest

are considered globally rare according to the ranks assigned by NatureServe (as of 2009), including little goblin moonwort (*Botrychium mormo*), rugulose grape-fern (*B. rugulosum*), Laurentian bladder fern (*Cystopteris laurentiana*), bog bluegrass (*Poa paludigena*), Hill's pondweed (*Potamogeton hillii*), and ram's-head lady's-slipper (*Cypripedium arietinum*). Note that the status of all Wisconsin rare plants was under review in late 2011 at the time of this writing, and this will result in changes to the Natural Heritage Working List. For current information on the status of Wisconsin's rare plants, see the latest Natural Heritage Working List (WDNR 2009). Among the rare plants that are better represented in the North Central Forest than anywhere elsewhere in Wisconsin are several of the global rarities mentioned above: little goblin moonwort, rugulose grape fern, and Hill's pondweed. Other rare plants for which this ecological landscape is especially important because they have been found nowhere else in Wisconsin or for which more than half of the known populations occur here are calypso orchid (*Calypso bulbosa*), Smith's melic grass (*Melica smithii*), Braun's holly fern (*Polystichum braunii*), foamflower (*Tiarella cordifolia*), and western Jacob's ladder (*Polemonium occidentale* var. *lacustre*). Several of these species are extremely rare in the state and represented by only

one or two known populations. In the case of the Wisconsin Threatened Braun's holly fern, however, all 39 records are from the North Central Forest Ecological Landscape. At least 28 plant species are represented here by half or more (but not all) of their known populations.

This should not be interpreted to mean that rare plant species that are represented by more populations in other ecological landscapes should be ignored in the North Central Forest. Rare species that appear more abundant elsewhere based solely on the number of populations may be represented in the North Central Forest by very large populations, by populations that have high estimated viability, by populations that contain unusual variations (e.g., geographic, genetic, or morphological), or by populations that have special statutory or administrative protection.

It should not be assumed that common and widespread natural communities, habitat types, habitats, and cover types lack the potential to support rare plants. In addition, the presence of a rare species population does not constitute an endorsement of past, present, or future management impacts or effects. Many factors may be involved, and in the absence of adequate monitoring data, it is difficult to draw supportable conclusions (see the "Rare Species, Species of Greatest



Fairy slipper (*Calypso bulbosa*) (Wisconsin Threatened) is a rare orchid that is most often associated with older boreal forest, northern white-cedar swamps, or stands of hemlock-hardwoods. Photo by Thomas Meyer, Wisconsin DNR.



In addition to browse sensitive conifers such as eastern hemlock, northern white-cedar, and Canada yew, some herbs may also be adversely affected by pressure from high populations of white-tailed deer. Among the potentially affected herbs are some of the forest orchids, including the Wisconsin Threatened ram's-head lady's-slipper. Photo by Thomas Meyer, Wisconsin DNR.

Conservation Need, and Responsibility Species” section in Chapter 3, “Comparison of Ecological Landscapes”). Rare plant species may occur in virtually every natural community type present in the North Central Forest, but not all natural communities are of equal importance to rare plants. Over one-third of the rare plant species documented here are associated with forest habitats. Northern Mesic Forest, the most abundant natural community in this ecological landscape, also supports 17 rarities, the largest number of rare plant species associated with any single community type or habitat feature in the North Central Forest. Northern Wet-mesic Forest (northern white-cedar swamp) is justly known for harboring rare plants and comes in a strong second, supporting at least 11 rare plant species. If these figures were adjusted and presented on a per-acre basis, the northern white-cedar swamps would outrank all of the other major vegetation types in terms of their ability to support rare plant species. This is one of the reasons why so much concern has been raised by ecologists, plant conservationists, and some land managers over the severe regeneration problems now documented in



Little goblin moonwort (Wisconsin Endangered) is a globally rare fern that occurs primarily in rich mesic hardwood forests of the western Great Lakes region. Photo by W.C. Taylor.

northern white-cedar-dominated forests across that community's state range and beyond.

Other terrestrial and palustrine habitats that are now known to be of high significance to rare plant species include open wetlands (most specifically the herb-dominated northern fens), bedrock features, beaches, and seepages. The latter three environments may accommodate narrow specialists tolerant of or adapted to conditions in few, if any, other types of habitats. At least 17 rare plant species in the North Central Forest are associated with aquatic habitats. Some of these categories overlap; for example, Braun's holly fern is associated with rocky bottomed, high gradient headwaters streams and seepages within stands of rich, mature mesic hardwood forest and sometimes on moist (“weeping”) cliffs, which are also embedded within mature stands of mesic hardwood or hemlock-hardwood forests.

Faculty and staff in the Department of Botany at the University of Wisconsin-Madison resampled sites that John Curtis and his associates had studied to provide the basis for the material on northern forests in *The Vegetation of Wisconsin* (Curtis 1959). The findings from this research (Wiegmann and Waller 2006) indicated that common and widespread native species, many of them abiotically pollinated graminoid plants, had increased, as had exotic species. Rarer, less generalized plants pollinated by animals experienced declines, some of them severe. Rosy twisted stalk (*Streptopus roseus*), a native mesophytic lily, showed declines of over 70% in 50 years. The losses are thought to be due to excessive herbivory by white-tailed deer, habitat desiccation, and various human disturbances to which this plant is poorly adapted. For additional information on floristic changes that have occurred over the past half century in Wisconsin's northern forests, see Waller and Rooney (2008).

Invasive nonnative earthworms are altering forest soil structure for sensitive native forest herbs (Gundale 2002), rendering some of the habitats used by these species as less



Braun's holly-fern (Wisconsin Threatened) is a shade-loving forest habitat specialist that grows on moist cliffs and on the margins of rocky, high-gradient, perennial headwaters streams. Photo by Eunice Padley, Wisconsin DNR.



Along with other widespread members of the lily family, rosy twisted-stalk has shown severe declines in northern Wisconsin forests. Causes are thought to include high levels of herbivory from white-tailed deer, desiccation, and human disturbances to which this and other native forest herbs are poorly adapted. Photo by Jason Hollinger.

suitable, or, in some cases, unsuitable. Less immediate threats to plants are posed by habitat fragmentation, simplification, and isolation, all factors that can make recolonization of a location from which a species has been eliminated difficult or impossible. Altered landscape patterns, patch sizes, age structure, and disturbance dynamics are factors that may interact with the threats mentioned above to impact the native flora. The negative impacts of increased edge in the northern forests have been documented many times and in many places in recent decades (e.g., Alverson et al. 1988, Balgooyen and Waller 1995).

Invasive plants are now making inroads in the North Central Forest Ecological Landscape and will negatively impact native plants by outcompeting them or altering their habitats so that they are no longer suitable. Public lands receiving heavy visitation, such as state parks and state wildlife areas, may be especially vulnerable, and certain forms of disturbance (e.g., heavy soil disturbance, especially when done by machines that have been used in areas already infested with

invasive plants) can also facilitate the colonization and spread of invasive species.

Fauna

Changes in Wildlife over Time

Many wildlife populations have changed dramatically since humans arrived on the Wisconsin landscape, but these changes were not well documented before the mid-1800s. This section discusses only those wildlife species documented as having occurred in the North Central Forest Ecological Landscape. Of those, this review is limited to species that were known or thought to be especially important here in comparison to other ecological landscapes. For a more complete review of historical wildlife in the state, see a collection of articles written by A.W. Schorger, compiled into the volume *Wildlife in Early Wisconsin: A Collection of Works by A.W. Schorger* (Brockman and Dow 1982).

The North Central Forest was important historically for many wildlife species, especially forest birds and large, wide-ranging forest mammals. This ecological landscape was particularly important for American black bear (*Ursus americanus*), gray wolf (*Canis lupus*), fisher (*Martes pennanti*), American marten (*Martes americana*), bobcat (*Lynx rufus*), American beaver (*Castor canadensis*), and North American river otter (*Lontra canadensis*). Neotropical migrant birds and forest raptors were likely important here, as were Bald Eagle (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), and Common Loon (*Gavia immer*) (see Chapter 14, “Northern Highland Ecological Landscape,” for historical descriptions of the latter three species). As forests were logged in the late 19th and early 20th century and the North Central Forest was inhabited by Euro-American settlers, wildlife populations changed.

Historically, the gray wolf was found throughout Wisconsin (Schorger 1942). As the southern part of the state was settled and bounties were imposed, gray wolf populations persisted only in the more remote portions of northern Wisconsin by the 1920s (Thiel 1993). Gray wolf populations continued to decline in northern Wisconsin until 1958 when the last Wisconsin gray wolf was thought to have been killed by a car in Bayfield County. Occasional sightings of gray wolves occurred throughout the 1960s and 1970s, but they were thought to be lone animals wandering here from Minnesota or Michigan. Not until the late 1970s was it determined that gray wolves had again become established and were breeding in Wisconsin (Wydeven et al. 2009). Gray wolves continued to emigrate from Minnesota and breed in Wisconsin, and by 2010 the Wisconsin wolf population had increased to a winter population of almost 700 individuals (Figure 12.9). This ecological landscape is very important for gray wolves, having about 49% of the state population within its boundary in 2008 (Wydeven et al. 2008).

Initial colonization of gray wolves within the region occurred within areas of low road densities (Thiel 1985, Mladenoff et al. 1995). As gray wolf populations expanded,

road density became less important as a factor in habitat selection, and wolves seemed to readily spread into areas with extensive forest cover and lack of agricultural land (Mladenoff et al. 2009). Although habitat selection of gray wolves has become more relaxed as the population has spread across Wisconsin (Figure 12.10), these areas of low road density will continue to serve as core wolf areas (Mladenoff et al. 2009). Large block management that maintains these areas of low road density will continue to help maintain long-term viability of gray wolves in Wisconsin. See the “Significant Wildlife” section below for current status of gray wolves in Wisconsin.

Like the gray wolf, cougars (*Puma concolor*) were once found throughout the state, but as southern Wisconsin was settled, cougars were only found in the northern part of the state. The last cougar was killed near Butternut in Ashland County in 1884 (Schorger 1942). Sporadic sightings of cougars occur today in the North Central Forest Ecological Landscape and appear to be dispersing animals that are moving into and/or through the state from the west, especially from the Black Hills of South Dakota (Wiedenhoef and Wydeven 2009).

The American marten occurred in forested areas of Minnesota, Wisconsin, and Michigan and had a preference for areas with conifers (Schorger 1942). The American marten seemed to be more numerous than the fisher based on fur trade records (Schorger 1942, Wydeven and Pils 2008). The rapid decline of the American marten was caused by an unregulated fur trade and large-scale logging of conifers from the forests. The last known historical capture of an American marten was from Maple,

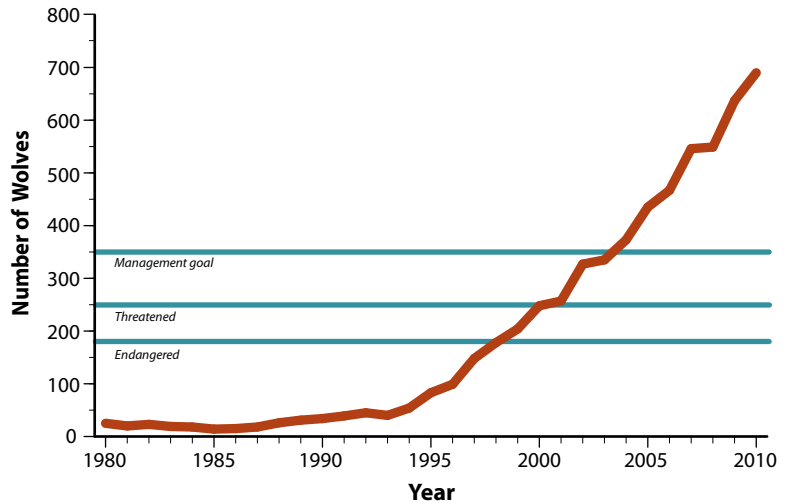


Figure 12.9. Number of gray wolves in Wisconsin, 1980–2010. Data from Adrian Wydeven, Wisconsin DNR.



The gray wolf has recently recolonized much of the North Central Forest. Photo by Herbert Lange.

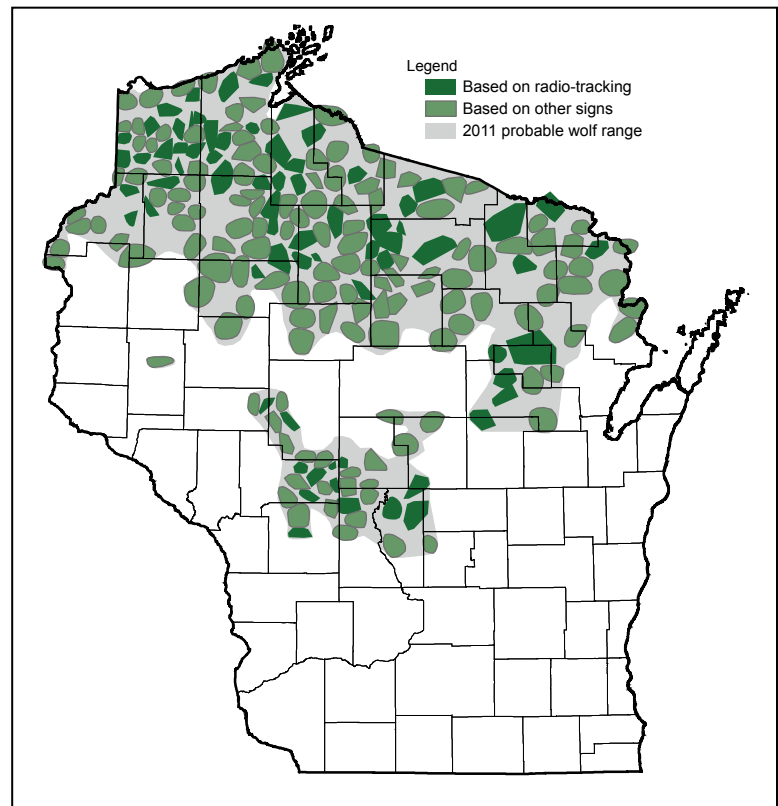


Figure 12.10. Gray wolf territories in Wisconsin and probable gray wolf distribution, based on 2011 data from Adrian Wydeven, Wisconsin DNR.

in Douglas County, in 1925. The last recorded historical sighting of an American marten was in Sawyer County in 1939 (Schorger 1942). Since then, three reintroduction attempts have been made: two in the North Central Forest and the other in the Apostle Islands, where an unsuccessful attempt was made to reintroduce American marten on Stockton Island in 1953 (Wydeven and Pils 2008). The U.S. Forest Service and Wisconsin DNR released 172 American martens from Ontario and Colorado into the Nicolet portion of the Chequamegon-Nicolet National Forest from 1975 to 1983. Only 27 of the 124 American martens released the first winter were females, and some appeared to be in poor condition (Kohn and Eckstein 1985). This population has become established and has remained stable in the Nicolet portion of the National Forest but has not flourished or expanded as it has just across the border in Upper Michigan. Another reintroduction of American marten was done in the western part of the North Central Forest Ecological Landscape in the Chequamegon portion of the Chequamegon-Nicolet National Forest in 1987–90. During this time, 139 American martens were captured in northern Minnesota and released on the Chequamegon National Forest (Williams et al. 2007). This population has persisted but has been declining. A third reintroduction to bolster the Chequamegon National Forest marten population began in 2008 and continued through 2010. For a detailed account of American marten stocking in Wisconsin, see Williams et al. (2007). The current distribution of American marten is shown in Figure 12.11.

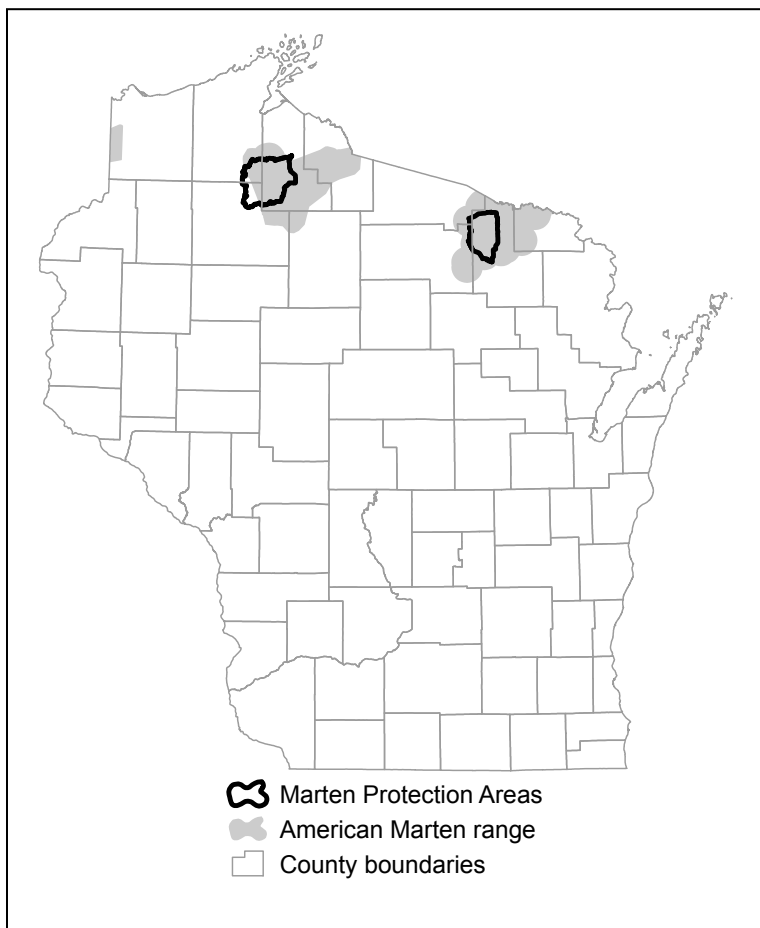


Figure 12.11. Range of the American marten in Wisconsin (Woodford 2013).

The fisher had a similar historical range to the American marten in the forested regions of northern Wisconsin, but it was more common in hardwood forests, and its range extended farther south (Schorger 1942). There are records of fishers as far south as La Crosse, Milwaukee, Jefferson, and Sauk counties. In both La Crosse and Sauk counties, it was described as being numerous. In northern Wisconsin, the fisher was not as numerous as the American marten. Extensive logging, wildfires, and unregulated trapping dramatically reduced the fisher population by the 1900s (Kohn et al. 1993, Wydeven and Pils 2008). Fishers were given legal protection in 1921, but the population continued to decline. Only three fishers were trapped in the 1920–21 trapping season. The last verified historical report of a fisher in Wisconsin was in 1932. The U.S. Forest Service and the Wisconsin Conservation Department cooperated to reestablish the fisher in Wisconsin during 1956–67. Sixty fishers from New York and Minnesota were released in the Nicolet National Forest during 1956–63, and 60 fishers



The extirpated American marten has been reintroduced to Wisconsin at several locations within the North Central Forest. Recovery has been slow, and success of the reintroduction efforts remains uncertain. Photo by Erwin and Peggy Bauer.

from Minnesota were released into the Chequamegon National Forest in 1966–67 (Kohn et al. 1993). Petersen et al. (1977) reported that fishers occurred throughout the northern quarter of the state by 1975. For a detailed account of fisher stocking in Wisconsin, see Williams et al. (2007). Today the fisher occupies almost all suitable habitat in the state. The population is currently estimated at over 6,900 animals.

Historically, the American beaver was present in the North Central Forest as it was across other parts of the state. As elsewhere in Wisconsin, American beaver populations declined dramatically with unregulated trapping and hunting for the fur trade through the 1700s and mid-1800s (Schorger 1965). American beaver populations have recovered, and they are now common in this ecological landscape because of the many lakes and streams and the abundance of aspen and other preferred foods.

Based on trapping records, the North American river otter was historically as abundant, or more abundant, than the American beaver across the state (Schorger 1970). As occurred with the American beaver, North American river otter populations declined dramatically throughout the state because of unregulated trapping for the fur trade. Today North American river otter populations have recovered. The fall 2013 population estimate was approximately 10,100 North American river otters (Rolley et al. 2013b), and trapping records show North American river otters were trapped in 67 of the 72 counties in the state (Dhuey and Olson 2011).

White-tailed deer were found throughout the state and were likely more abundant in southern Wisconsin than in the northern part of the state (Schorger 1953) at the time of Euro-American settlement. Northern Wisconsin was primarily mature coniferous-deciduous forest and not optimal habitat, limiting the white-tailed deer population there. The white-tailed deer population expanded in northern Wisconsin after large-scale logging took place in the late 1800s. The former mature, mixed conifer-hardwood forest in northern Wisconsin was eventually replaced by young hardwoods, including vast acreages of aspen, white birch, and other forage plants that provided an abundant food supply for white-tailed deer. However, the large number of settlers that followed logging depended heavily on venison for food. Subsistence harvest, together with market hunting, likely reduced the state white-tailed deer population to its lowest level around the turn of the 20th century. Hunting regulations began in

1897, but it was not until the 1920s that overhunting was curbed. Conservative harvests in the early 1900s along with regrowth of the northern forest permitted white-tailed deer population to increase in the north. As white-tailed deer populations grew, the impacts of browsing on forest vegetation became apparent. Starvation of white-tailed deer was first reported in 1930. From 1934 through 1954, large scale feeding was done in an effort to prevent starvation. Failure of this feeding program prompted attempts to institute antlerless white-tailed deer harvests to control and reduce the white-tailed deer herd. After much public resistance to shooting female white-tailed deer, white-tailed deer management programs were put in place setting white-tailed deer population goals for units within the state and using antlerless white-tailed deer harvests in an attempt to keep the white-tailed deer at the established goals (Figure 12.12).

White-tailed deer populations in the North Central Forest are large today compared to those present prior to Euro-American settlement. Logging and other human activities have maintained large acreages of the northern forest in young deciduous growth, which has provided abundant food for white-tailed deer. Relatively mild winters during the decades of the 1990s and 2000s have prevented winter starvation and allowed the white-tailed deer herd to increase. Winter feeding of white-tailed deer by well-intentioned people became popular in the 1990s and may be contributing to increased winter survival and increased production of offspring the following spring. The white-tailed deer herd has often been above goal

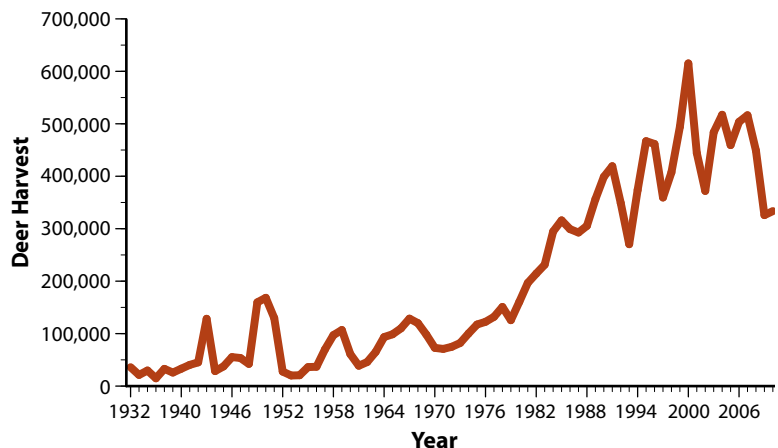


Figure 12.12. Statewide white-tailed deer harvest, 1932–2010 (Wisconsin DNR unpublished data).

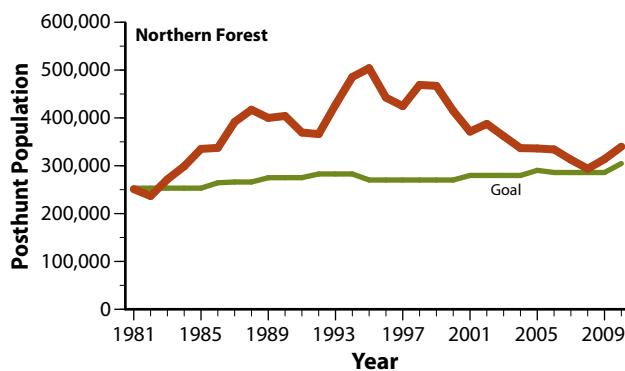


Figure 12.13. White-tailed deer population size in relation to population goal in the northern forest deer management region, 1981–2010 (Wisconsin DNR unpublished data).

for most Northern Forest units in the last decade (Figure 12.13), and overbrowsing, with heavy negative impacts on vegetation, has occurred in many forested portions of this ecological landscape. Only in 2008–11 have white-tailed deer populations been near or below goals. For example, of the 26 deer management units that were within or partially within the North Central Forest (more than half of the deer management units in the ecological landscape), eight of the 2012–13 overwinter deer population estimates were more than 10% over goal, 11 were within 10% of goal, and seven were more than 10% below goal (Wisconsin DNR unpublished data).

Moose (*Alces americanus*) were found throughout the northern one-third of Wisconsin with reports of moose as far south as the Lake Winnebago area and one report each from Green Lake County and Sauk County (Schorger 1956). The largest moose populations were in the northwest part of the state (Figure 12.14) where they were considered fairly common. Due to uncontrolled hunting, few moose existed in the state after 1900, and they remain rare today, limited to those likely wandering into Wisconsin from Michigan and Minnesota (Wiedenhoef and Wydeven 2009).

American black bears were abundant throughout the northern and central parts of Wisconsin but were also found, with less frequency, in the southern part of the state. By the late 1880s, American black bears were gone from southeastern Wisconsin, and by the mid-1940s they had disappeared from the central part of the state (Schorger 1949). American black bears remained in the north but in reduced numbers during this time. Today American black bears are carefully managed, and harvests are controlled by a quota system. It was estimated that in 2013, 21,600 American black bears occurred in the state (Rolley et al. 2013a). American black bears have recolonized central Wisconsin and are wandering into southern Wisconsin with more frequency in recent years. The northern third of the state, which includes the North Central Forest Ecological Landscape, harbors almost 14,200 American black bears, 66% of the American black bears in the state.

The Spruce Grouse (*Falcipennis canadensis*) was historically common in the northern part of the state where conifers were abundant. Although central Wisconsin contained areas with abundant conifers, Spruce Grouse were not reported that far south. After the Cutover, the Spruce Grouse quickly declined due to habitat loss and alteration.

By the early 1900s, it was difficult to find them (Schorger 1942). Today Spruce Grouse occur sporadically across the north where extensive dense stands of conifers are found (Worland et al. 2009). They use swamp conifers (especially black spruce and, to a lesser extent, tamarack), some upland conifer habitats (e.g., jack pine), and the edges between upland and lowland conifer stands. Two population concentration areas occur: one on the western side of this ecological landscape and the other in the Northern Highland (Figure 12.15).

Ruffed Grouse (*Bonasa umbellus*) was found throughout the state prior to Euro-American settlement. It was not common in the northern part of the state where old coniferous and hardwood forests predominated (Schorger

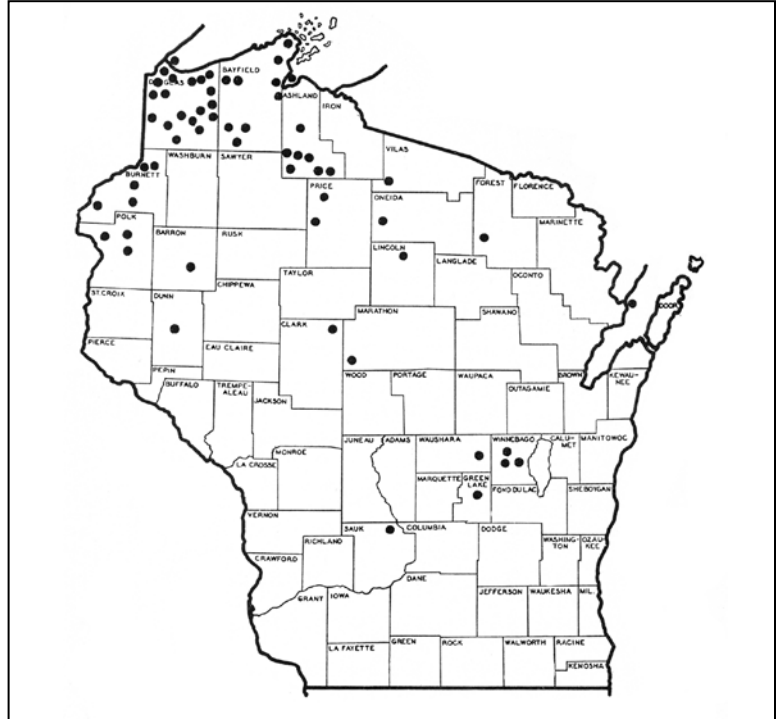


Figure 12.14. Historical records of moose in Wisconsin. Figure reproduced from Schorger (1956) by permission of the Wisconsin Academy of Sciences, Arts and Letters.

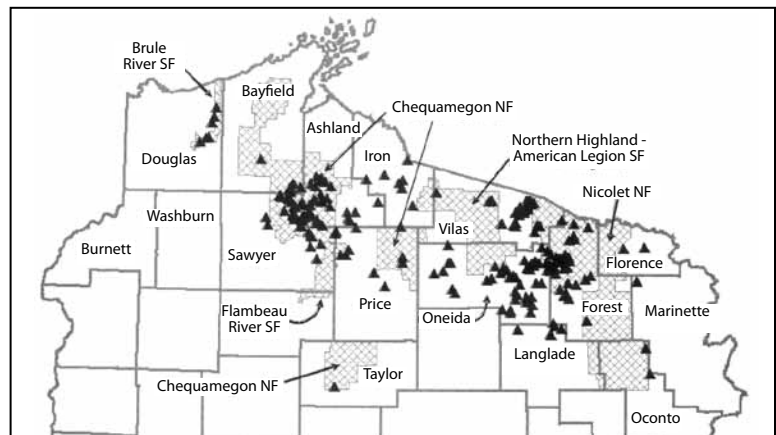


Figure 12.15. Spruce Grouse observations in Wisconsin, 1980–2008, shown by black triangles. Cross-hatched areas are national forests and state forests. Reproduced from Worland et al. (2009) by permission of the Wisconsin Society for Ornithology.



Spruce Grouse (Wisconsin Threatened) is a rare resident of coniferous habitats in the far north. The bird pictured is a female. Photo by Ray White.

1945). The oak openings, oak woodlands, and oak forests in the prairie-forest regions of central, southern, and western Wisconsin provided better habitat. Ruffed Grouse were described as abundant here and were often sold in the markets in Milwaukee and Chicago. Settlement initially increased habitat for Ruffed Grouse with the cessation of burning, especially in the open savannas, but by 1870 the decline of Ruffed Grouse began in the southern part of the state. Grazing of woodlots was listed as the “chief factor” in this decline. Ruffed Grouse populations increased in the north as lumbering took place during the latter half of the 19th century. After coniferous trees were removed, a younger, hardwood habitat became established that was more favorable to Ruffed Grouse. By 1900 the Ruffed Grouse was reported as “almost abundant” in the northern part of the state (Schorger 1945). Today Ruffed Grouse are common throughout northern and central Wisconsin, although abundance varies with a 10-year population cycle.

Significant Wildlife

Wildlife are considered significant for an ecological landscape if (1) the ecological landscape is considered important for maintaining the species in the state and/or (2) the species provides important recreational, social, and economic benefits to the state. To ensure that all species are maintained in the state, “significant wildlife” includes both common species and species that are considered “rare” (in this publication, “rare” includes species listed as endangered or threatened by either the State of Wisconsin or the federal government or species that are listed as “special concern” by the State of Wisconsin). Four categories of species are discussed: rare species, Species of Greatest Conservation Need (SGCN), responsibility species, and socially important species (see definitions in the text box). Because wildlife communities and habitats are the most efficient way to manage and benefit a majority of species, we also discuss management of different wildlife habitats in which significant fauna occur.

Categories of Significant Wildlife

- **Rare species** are those that appear on the Wisconsin Natural Heritage Working List as Wisconsin or U.S. Endangered, Threatened, or Special Concern.
- **Species of Greatest Conservation Need** are described and listed in the Wisconsin Wildlife Action Plan (WDNR 2005b) as those native wildlife species that have low or declining populations, are “indicative of the diversity and health of wildlife” of the state, and need proactive attention in order to avoid additional formal protection.
- **Responsibility species** are both common and rare species whose populations are dependent on Wisconsin for their continued existence (e.g., a relatively high percentage of the global population occurs in Wisconsin). For such a species to be included in a particular ecological landscape, a relatively high percentage of the state population needs to occur there, or good opportunities for effective population protection and habitat management for that species occur in the ecological landscape. Also included here are species for which an ecological landscape holds the state’s largest populations, which may be critical for that species’ continued existence in Wisconsin even though Wisconsin may not be in the heart of its global abundance.
- **Socially important species** are those that provide important recreational, social, or economic benefits to the state for activities such as fishing, hunting, trapping, and wildlife watching.

■ **Rare Species.** As of November 2009 (WDNR 2009), the Wisconsin Natural Heritage Working List documented 111 rare animal species within this ecological landscape, including 8 mammals, 25 birds, 6 herptiles, 12 fishes, and 60 invertebrates. These include one U.S. candidate for future listing, 9 Wisconsin Endangered species, 15 Wisconsin Threatened species, and 87 Wisconsin Special Concern species. See Appendix 12.D for the number of species with special designations documented within the North Central Forest Ecological Landscape. See Appendix 12.C for a comprehensive list of the rare animals known to exist in the North Central Forest Ecological Landscape.

■ **Federally Listed Species:** The gray wolf, which occurs in this ecological landscape, was removed from the federal endangered species list in January 2012, granting management authority to the State of Wisconsin. The Wisconsin state legislature passed a law in April 2012 authorizing hunting and trapping seasons for wolves and directing that wolf hunting and trapping seasons be held starting in the fall of 2012. The first hunting and trapping seasons of wolves were therefore conducted during October–December 2012. Wolves are now managed under a 1999 wolf management plan with addenda in 2006 and 2007, but the plan is being updated to reflect the

recent changes in wolf management in Wisconsin. The bullhead (sheepnose) mussel (*Plethobasus cyphus*) is a candidate for federal listing, the only U.S. **candidate species** in this ecological landscape.¹ The Bald Eagle (formerly U.S. Threatened) is also found here. The Bald Eagle (formerly U.S. Threatened) was delisted in 2007 and is protected under the federal Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act and is a special concern species on the Wisconsin Natural Heritage Working List.

■ **Wisconsin Endangered Species:** One Wisconsin Endangered mammal, American marten, is found in this ecological landscape. Two Wisconsin Endangered birds are found here: Loggerhead Shrike (*Lanius ludovicianus*) and Barn Owl (*Tyto alba*). Two Wisconsin Endangered mussels, purple wartyback (*Cyclonaias tuberculata*) and bullhead, occur in this ecological landscape, along with four other Wisconsin Endangered invertebrates, including northern blue butterfly (*Lycaeides idas*) and three dragonflies: extra-striped snaketail (*Ophiogomphus anomalus*), Saint Croix snaketail (*Ophiogomphus susbehcha*), and warpaint emerald (*Somatochlora incurvata*). No Wisconsin Endangered herptiles or fish occur here.

■ **Wisconsin Threatened Species:** No Wisconsin Threatened mammals occur in this ecological landscape. Four Wisconsin Threatened birds are found here, including Red-shouldered Hawk (*Buteo lineatus*), Yellow Rail (*Coturnicops noveboracensis*), Cerulean Warbler (*Setophaga cerulea*, listed as *Dendroica cerulea* on the Wisconsin Natural Heritage Working List), and Spruce Grouse. Two Wisconsin Threatened herptiles, wood turtle and Blanding's turtle (*Emydoidea blandingii*), and five Wisconsin Threatened fish, including longear sunfish, greater redhorse, pugnose shiner (*Notropis anogenus*), Ozark minnow (*Notropis nubilus*), and gilt darter, occur here. Wisconsin Threatened invertebrate species documented in this ecological landscape include two mussels—salamander mussel (*Simpsonaias ambigua*) and ellipse (*Venustaconcha ellipsiformis*)—and two other invertebrate species—pygmy snaketail dragonfly (*Ophiogomphus howei*) and cherrystone drop (*Hendersonia occulta*), a tiny terrestrial snail.

■ **Wisconsin Special Concern Species:** Wisconsin Special Concern species include 7 mammals, 19 birds, and 4 herptiles within the ecological landscape. Seven Wisconsin Special Concern fish are listed in the Natural Heritage Inventory database for this ecological landscape, but one of them, the pugnose minnow (*Opsopoeodus emiliae*), no longer occurs here (J. Lyons, Wisconsin DNR, personal communication). Fifty invertebrate species are listed as Wisconsin Special Concern within this ecological landscape (see Appendix 12.C at the end of this chapter for a complete rare species list).

■ **Species of Greatest Conservation Need.** Species of Greatest Conservation Need (SGCN) appear in the Wisconsin Wildlife Action Plan (WDNR 2005b) and include species already recognized as endangered, threatened, or special concern on state or federal lists along with nonlisted species that meet the SGCN criteria. There are 31 birds, 10 mammals, 6 herptiles, and 4 fish species listed as SGCN for the North Central Forest Ecological Landscape (see Appendix 12.E for a complete list of SGCN in this ecological landscape and the habitats with which they are associated).

■ **Responsibility Species.** The North Central Forest is in one of the continent's most important breeding regions for forest birds (Terborgh 1992, Green 1995, Cutright et al. 2006). It is especially important to bird species that require large blocks of unfragmented forested habitat, such as many neotropical migrant songbirds and forest raptors, e.g., Northern Goshawk (*Accipiter gentilis*) and Red-shouldered Hawk. The Wisconsin breeding bird atlas project recorded 111 species in one 10-square-mile area within this ecological landscape, demonstrating the high bird species diversity that occurs here (Cutright et al. 2006). In addition, many rare forest birds breed here, e.g., Swainson's Thrush (*Catharus ustulatus*), Black-backed Woodpecker (*Picoides arcticus*), and Black-throated Blue Warbler (*Setophaga caerulescens*, listed as *Dendroica caerulescens* on the Wisconsin Natural Heritage Working List). Wetlands, especially coniferous and deciduous forested wetlands, are abundant here. Many of these wetlands are embedded within a matrix of extensive upland forest, and this vegetation pattern provides habitat for numerous forest-dependent species.

A long-term habitat-based breeding bird survey in the Nicolet National Forest, coordinated by Dr. Robert Howe, indicated that 45 species declined significantly from 1989 to 2002 (compared with only seven species that increased significantly) in northeastern Wisconsin (Howe and Roberts 2005). Declining species include neotropical migrants, short-distance migrants, permanent residents, forest interior species, wetland species, early successional species, old-growth forest species, and birds of open country. Therefore a single explanation for the declines is unlikely. Especially troubling are the data for species like Eastern Kingbird (*Tyrannus tyrannus*), Golden-winged Warbler (*Vermivora chrysoptera*), Baltimore Oriole (*Icterus galbula*), and several others that have shown consistent declines in all parts of the Nicolet National Forest as well as in the federal breeding bird survey.

Another long-term bird survey (18 years) has been conducted on the Chequamegon National Forest (Danz et al. 2008). One of the main goals of this monitoring program is to identify potential long-term declines of forest bird species, especially for species of conservation concern such as the Eastern Wood-Pewee (*Contopus virens*), Winter Wren (*Troglodytes hiemalis*), and Hermit Thrush (*Catharus guttatus*). In 2007 Danz et al. (2008) studied 60 bird species for trends in the Chequamegon National Forest; of these, 13 species increased

¹When this material was written, it was based on the 2009 Wisconsin Natural Heritage Working List (WDNR 2009). The bullhead mussel was listed as U.S. Endangered in 2012.

and 11 species decreased. Compared to 2006 observations, eight new species were noted to be increasing. Yellow Warbler (*Setophaga petechia*) and Purple Finch (*Carpodacus purpureus*) had the greatest rates of increase (greater than 10%), but neither species was widespread in the Chequamegon National Forest. Indigo Bunting (*Passerina cyanea*), American Redstart (*Setophaga ruticilla*), and Red-breasted Nuthatch (*Sitta canadensis*) were fairly widespread, with increasing trends. Northern Waterthrush (*Parkesia noveboracensis*) was observed to be increasing in 2006, but in 2007 its population was stable. Danz et al. (2008) observed five fewer decreasing species in 2007 compared to 2006. Even though Eastern Wood-Pewee, Winter Wren, and Hermit Thrush were well represented on the Chequamegon National Forest, these species showed some of the greatest declines (5–9% annually). Great Crested Flycatcher (*Myiarchus crinitus*) and Blue-headed Vireo (*Vireo solitarius*) were less widespread on the forest than previously, with 5% annual declines. The Red-winged Blackbird (*Agelaius phoeniceus*) and Evening Grosbeak (*Coccothraustes vespertinus*) had the highest rates of decrease in the Chequamegon National Forest, and both trends may be more susceptible to site-specific influences than other species; Saur et al. (2014) observed substantial declines in other parts of their ranges. Veery (*Catharus fuscescens*), Brown Thrasher (*Toxostoma rufum*), Yellow-rumped Warbler (*Setophaga coronata*), Black-throated Green Warbler (*Setophaga virens*), and Ovenbird (*Seiurus aurocapilla*) also declined, although at a lesser rate. Danz et al. (2008) noted that the declining trends appeared to be consistent across years of their study and not just limited to a few years with very high or very low abundance. They also noted that ground nesting species showed “highly significant declines” on all national forests in the western Great Lakes region. The continuing decline of these common species are a concern and warrant management attention.

The core Wisconsin range for forest mammals such as the fisher, American marten, American black bear, bobcat, American beaver, and North American river otter occurs in this ecological landscape. This ecological landscape is critical to the survival of the American marten in Wisconsin since both reestablished populations are found here. The North Central Forest is the most important ecological landscape in Wisconsin for gray wolves because almost half of the state's gray wolves occur here. As of 2008, at least 262 gray wolves in 70 packs were found here (Wydeven et al. 2008). Moose are occasionally seen in this ecological landscape (Wiedenhoeft and Wydeven 2009). An introduced herd of elk (*Cervus canadensis*) that is slowly increasing in size is located near Clam Lake in the northwestern part of this ecological landscape.

High populations of Bald Eagle, Osprey, and Common Loon are associated with the North Central Forest, which is important for their continued survival in Wisconsin and in the Upper Great Lakes region. The North Central Forest is second in importance only to the much smaller Northern Highland Ecological Landscape and its abundant lakes for supporting breeding populations of these species. The North

Significant Wildlife in the North Central Forest Ecological Landscape

- Many neotropical migrant songbirds, forest interior species, boreal conifer specialists (e.g., Boreal Chickadee, Gray Jay, Spruce Grouse, Connecticut Warbler), peatland specialists (e.g., Yellow Rail, Le Conte's Sparrow), certain marsh species (e.g., Trumpeter Swan, Black Tern, American Bittern), and forest raptors (e.g., Northern Goshawk, Red-shouldered Hawk) are found here.
- The North Central Forest Ecological Landscape is in the heart of an area with the highest diversity of breeding birds in North America, as documented by the federal breeding bird survey.
- Fish-eating birds such as Bald Eagle, Osprey, and Common Loon are associated with lakes and rivers here.
- Mammals: Gray wolf, American black bear, elk, American beaver, North American river otter, fisher, American marten, bobcat, white-tailed deer, and snowshoe hare.
- Herptiles: Wood turtle, mink frog, and four-toed salamander (*Hemidactylium scutatum*).
- Fish: Muskellunge, walleye, largemouth and smallmouth bass, brook trout, bluegill, yellow perch, lake sturgeon, greater redhorse, longear sunfish, Ozark minnow, gilt darter, and pugnose shiner.
- Insects: Freija fritillary, frigga fritillary, northern blue butterfly, extra-striped snaketail, Saint Croix snaketail, and warpaint emerald.

Central Forest contains most of the Wisconsin portion of the range for the Golden-winged Warbler, a rare and declining species with most of its continental population found in Wisconsin and Minnesota. Important breeding habitat for herptiles occurs here because of the large number of lakes, wetlands, and ephemeral ponds. This ecological landscape is also important for rare aquatic invertebrates due to its many high-quality lakes and streams.

■ **Socially Important Fauna.** Species such as white-tailed deer, American black bear, American beaver, North American river otter, fisher, bobcat, Ruffed Grouse, American Woodcock (*Scolopax minor*), Mallard (*Anas platyrhynchos*), Wood Duck (*Aix sponsa*), and Ringed-necked Duck (*Aythya collaris*) are all important for hunting, trapping, and wildlife viewing in the North Central Forest. There are abundant populations and diverse species of birds here that provide bird watching and bird feeding enjoyment for local residents and visitors. This ecological landscape has an important warmwater fishery that supports sought after game fish such as muskellunge, northern pike, walleye, small and largemouth bass,

and panfish such as bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), and black crappie (*Pomoxis nigromaculatus*). It has an important coldwater stream fishery for brook trout, especially in the eastern portion of the ecological landscape. There are also coldwater streams supporting populations of nonnative brown trout (*Salmo trutta*).

■ **Wildlife Habitat and Communities.** The North Central Forest may be a “source area” for many forest interior species, aquatic animals, and habitat specialists. Large blocks of unfragmented forest make this ecological landscape desirable for forest interior bird species (e.g., many neotropical migrant songbirds), including forest raptors (e.g., Northern Goshawk and Red-shouldered Hawk). There is high potential to manage, maintain, or restore large blocks of unfragmented forest habitat composed of a mix of conifers and hardwoods that will benefit forest interior species. The forested portions of the North Central Forest are extensive and only moderately fragmented compared with forests in most of Wisconsin’s other ecological landscapes. Developing or reestablishing ecological connections between and within the large public lands within this ecological landscape is possible. Some of the large river corridors could also serve to connect the North Central Forest with other ecological landscapes.

Older forests, which are currently rare throughout this ecological landscape, are needed to support species such as Black-throated Blue Warbler, Blackburnian Warbler (*Setophaga fusca*), Winter Wren, Blue-headed Vireo, Spruce Grouse, Red-shouldered hawk, Northern Goshawk, and American marten. Currently, aspen is found in many areas of these forests, which at certain stages can be important for species utilizing young, dense deciduous woody growth as habitat, such as white-tailed deer, Ruffed Grouse, American Woodcock, Chestnut-sided Warbler (*Setophaga pensylvanica*), and Golden-winged Warbler. All of these species also use other habitats, including seral stages other than those provided by young aspen.



The Blackburnian Warbler is a neotropical migrant that is a characteristic breeder where Wisconsin’s northern forests are composed of large conifers, especially eastern hemlock, eastern white pine, and white spruce. Photo by Brian Collins.

A study comparing old-growth forests to managed even-aged and managed uneven-aged forests in northern Wisconsin and upper Michigan found that Blackburnian Warbler, Northern Parula (*Setophaga americana*), Winter Wren, Yellow-rumped Warbler, Brown Creeper (*Certhia americana*), Hermit Thrush, Pileated Woodpecker (*Dryocopus pileatus*), and Red-breasted Nuthatch were significantly associated with old-growth stands (Howe et al. in prep.). Blackburnian Warbler, Yellow-rumped Warbler, and Hermit Thrush were more closely associated with hemlock-dominated stands. Pileated Woodpecker was only documented in hardwood stands. Mossman (1997) found that amphibians, including spotted (*Ambystoma maculatum*), blue-spotted (*Ambystoma laterale*), and red-backed salamander (*Plethodon cinereus*), were more abundant in unfragmented old-growth forests than in managed forest stands. However, small mammals and medium-sized mammalian predators such as weasels (*Mustela* spp.), fisher, red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), and coyote (*Canis latrans*), were more abundant in managed forest stands than in unfragmented old-growth forests (Mossman 1997).

The extensive forests of this ecological landscape support many wide-ranging northern mammal species, such as fisher, American marten, bobcat, North American river otter, American black bear, and moose. This ecological landscape is very important to the state’s gray wolf population and is likely to remain so as long as white-tailed deer and large areas with low road densities and light development are available.

Bald Eagle, Osprey, and Common Loon nest along and near the shores of lakes and streams here. Maintaining large trees, including **supercanopy** trees, near shorelines as nesting sites for Bald Eagles and Ospreys will provide nesting habitat for these species. Limiting human disturbance will benefit all three of these species. Open wetlands such as marshes and sedge meadows on lake and stream margins support Trumpeter Swan (*Cygnus buccinator*), Black Tern (*Chlidonias niger*), American Bittern (*Botaurus lentiginosus*), and American bullfrog (*Lithobates catesbeianus*). Wild rice lakes occur in the North Central Forest, and these are used as foraging and breeding sites by ducks, geese, and other water birds. Extensive sedge meadow, fen, and bog habitats support rare birds such as Yellow Rail, Northern Harrier (*Circus cyaneus*), and Le Conte’s Sparrow (*Ammodramus leconteii*).

Peatlands include forested and nonforested communities, and these support a diverse suite of animals that are associated with North America’s boreal regions and reach their southern range limits in northern Wisconsin. The forested peatlands are conifer dominated, and associated species include Spruce Grouse, Gray Jay (*Perisoreus canadensis*), Boreal Chickadee (*Poecile hudsonicus*), Red Crossbill (*Loxia curvirostra*), Northern Saw-whet Owl (*Aegolius acadicus*), Cape May Warbler (*Setophaga tigrina*, listed as *Dendroica tigrina* on the Wisconsin Natural Heritage Working List), Connecticut Warbler (*Oporornis agilis*), and Evening Grosbeak. Rare boreal lepidoptera such as the freija fritillary (*Boloria*

freija) and frigga fritillary (*Boloria frigga*) have been documented in more open peatland communities such as Muskeg and Poor Fen, and there is high potential for additional discoveries from this taxonomic group.

Alder Thicket habitats are widespread here and provide important habitat for species such as Golden-winged Warbler, American Woodcock, Veery, wood turtle, and snowshoe hare (*Lepus americanus*). Upland “shrub” habitats such as regenerating cut-overs are significant to Brown Thrasher, Chestnut-sided Warbler, and Mourning Warbler (*Geothlypis philadelphia*).

Ephemeral ponds are very common in the North Central Forest. Ephemeral ponds (also known as vernal pools) are important *refugia* and breeding sites for a wide range of amphibian and aquatic invertebrate species within forested landscapes. These ponds can harbor invertebrates known only from these specialized habitats. Ephemeral ponds are also important feeding areas for some mammals, birds, herptiles, and invertebrates.

Many streams support not only coldwater and coolwater fish assemblages, which include native brook trout, but also very diverse assemblages of all the other organisms that comprise a complete coldwater or coolwater community. Impairment due to mercury in fish tissue generally occurs at higher concentrations in reservoirs and drainage lakes because of their higher sediment loading, which tends to support sulfur-reducing bacteria that often drive the methylation process. Higher levels of acidification (lower pH) are conducive to methylation and greater bioavailability of mercury (Scudder et al. 2009, USGS 2009).

The Pine River provides habitats that support a greater diversity of rare aquatic invertebrate species than any other stream surveyed by aquatic biologists in this ecological landscape. The overall diversity of aquatic organisms, both rare and more common, is even higher in the upper Wolf River than in the Pine (though the Wolf has fewer mussel species). The upper Wolf’s substrate of sand, gravel, and bedrock provides a wealth of habitat for this extremely varied aquatic community that includes 28 Wisconsin Endangered, Threatened, and Special Concern invertebrate species. These rare species include the Wisconsin Threatened Pygmy snaketail dragonfly. Swamp Creek, a tributary to the Wolf River that was heavily inventoried during the Crandon Mine review, includes rare species that are more characteristic of larger streams, because of its connection to the Wolf. The clean water and diverse substrate of the Brule River (a coolwater stream in Florence County, along the Michigan border in the northeastern part of the ecological landscape) harbors populations of two Wisconsin Special Concern species, a riffle beetle (*Stenelmis bicarinata*), and a caddisfly (*Hydropsyche bidens*). Other coolwater streams notable for their biologically intact invertebrate communities include Big Weirgor Creek (in the Blue Hills, Rusk County), the Brunsweller River (Ashland County), and Pickerel Creek (Forest County).

The Namekagon River is a major tributary to the St. Croix and exhibits good invertebrate diversity, a reflection in large

part of the high diversity of aquatic organisms found in the St. Croix River, into which it flows. The middle section of the West Branch of the Montreal River flows through a shaded steep-sided gorge in the Trap Hills, east of the Penokee Range. This gorge may limit warming by the summer sun and enable survival of a population of the rare eastern elliptio (*Elliptio complanata*) mussel, a Species of Greatest Conservation Need.

The Chippewa and Flambeau rivers support a wealth of mussels, dragonflies, and other aquatic invertebrates compared to similar sized streams in Wisconsin. Several aquatic species formerly thought to be rare based on regional data have been found to have populations that are more robust than was previously believed, due to increased and systematic surveying of the many relatively intact *stream segments* of these two rivers. The Chippewa and Flambeau rivers are also important for the lake sturgeon and greater redhorse, the Chippewa, lower Flambeau (below Thornapple Dam), and Jump rivers are important for gilt darters, and many small coolwater streams in southern Oneida and Lincoln counties support reddsides (*Clinostomus elongatus*), which reach the northern edge of their range here.

The South Fork of the Flambeau, especially the segment that crosses the Flambeau River State Forest, has a rocky substrate that supports many species of aquatic insects. Mussel species are not as abundant as in the Chippewa River (into which the Flambeau flows), because the Chippewa has a greater variety of habitats by virtue of its larger size. The Jump River supports two Wisconsin listed dragonfly species—the Wisconsin Threatened pygmy snaketail and the Wisconsin Endangered extra-striped snaketail—and the Wisconsin Endangered bullhead mussel, a species adapted to swifter current and which is a candidate for federal listing under the U.S. Endangered Species Act.



The Sioux snaketail (*Ophiogomphus smithi*) was only recently (2004) established as a species and uses rivers and streams that are sand-bottomed. It is only known from a handful of counties in western Wisconsin. Photo © K. Tennessen 2014.

The Yellow River, in Taylor and Chippewa counties, supports the North Central Forest's only population of the Wisconsin Threatened ellipse mussel and a population of the Wisconsin Special Concern sand snaketail dragonfly (*Ophiogomphus smithi*). The Couderay River supports one Wisconsin threatened and one Wisconsin Endangered dragonfly as well as an overall high diversity of aquatic invertebrate species.

Natural and Human Disturbances

Fire, Wind, and Flooding

Windthrow was the primary natural disturbance that occurred here historically. Storm events most often resulted in many small windfall patches (Frelich and Lorimer 1991), but some large-scale catastrophic windthrow events occurred and made up the majority of area in windthrow prior to Euro-American settlement (Schulte and Mladenoff 2005). A large-scale wind disturbance occurred on 4 July 1977 (Figure 12.16) when a severe squall line of thunderstorms crossed eastern Minnesota and north central Wisconsin and blew down and uprooted trees on an estimated 344,000 hectares of forestland (Canham and Loucks 1984). Estimated return time for such catastrophic wind throw events is about 1,200 years. These catastrophic wind events can result directly in forest stand replacement and provide downed and dead trees and slash as fuel for fires.

Smaller-scale severe windthrow events have occurred more frequently (Schulte and Mladenoff 2005). Because intervals between severe wind events were longer than the maximum age of shade tolerant trees, Frelich and Lorimer (1991) suggested that wind-prone landscapes were dominated by mature to old-age forests. Light to moderate levels of windthrow likely facilitated or maintained a dominance of eastern hemlock,

which was multi-aged, while heavy windthrow may have favored hardwoods (Schulte and Mladenoff 2005).

Three sources of severe winds that can cause windthrow have been suggested (Canham and Loucks 1984). Severe low pressure systems can generate strong winds that cause trees to be uprooted and create canopy gaps but seldom achieve complete canopy removal. Tornadoes can cause complete canopy removal but are usually in narrow strips. The most common wind force that has created complete canopy removal in large patches in Wisconsin northern forests have been **downbursts** from thunderstorms.

Natural disturbance regimes have been altered by human activities. Wind disturbance, in the mesic and wet portions of the ecological landscape, is likely reduced from historical conditions because forests are now generally younger and less subject to being windthrown. As a result, canopy gaps and tip-up mounds are scarcer and the lack of these microhabitats can negatively impact herptiles and species like the Black-throated Blue Warbler and American marten.

Fire was likely a minor historical disturbance in the North Central Forest Ecological Landscape although it may have played a role in some parts of the ecological landscape adjacent to fire prone areas (Frelich and Lorimer 1991). Although wildfire may not have been a frequent or widespread disturbance here, even infrequent fire events may have been important to forest landscape composition. For example, huge eastern white pines several centuries old were scattered at low densities in many parts of the North Central Forest Ecological Landscape. These provided important structural elements and were among the first timber sought by loggers in the 19th century.

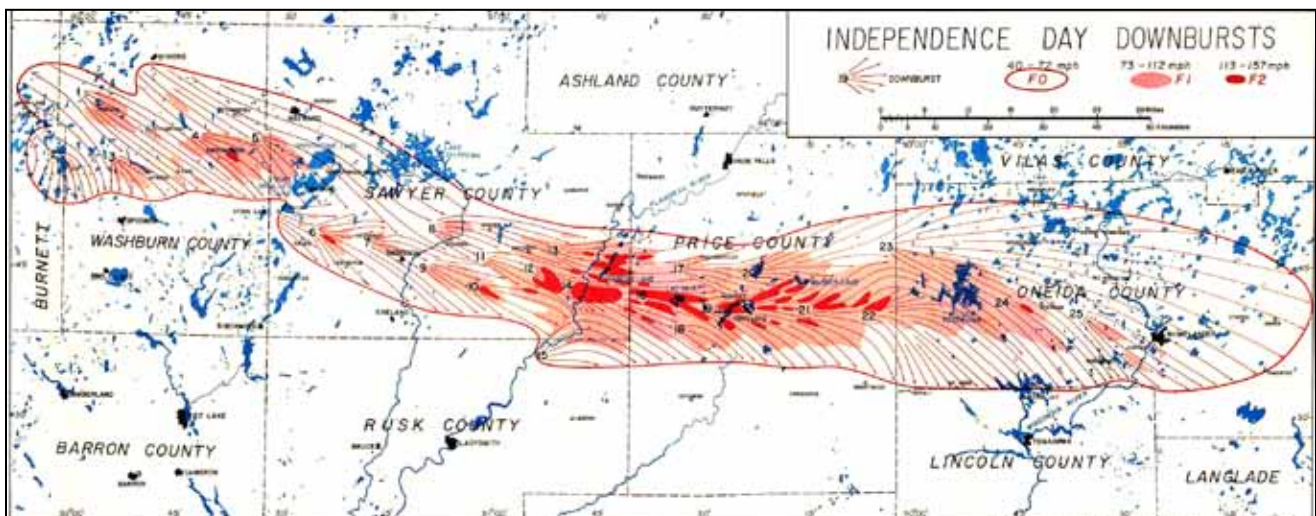


Figure 12.16. Recent example of large-scale wind disturbance, Flambeau River State Forest. Downburst winds from the July 4th, 1977, **derecho** were estimated at 135 miles per hour on the Flambeau River State Forest west of Phillips, Wisconsin, flattening the largest remaining acreage of old-growth forest on state lands. This storm traveled 800 miles in about 14 hours, destroying or severely damaging roughly 1,000,000 acres of forest, mostly in northwestern and north central Wisconsin. Events of this magnitude and severity are fortunately infrequent, but when they do occur, they have major effects on ecological processes and local economies. Illustration reproduced with permission from Fujita (1978): Manual of downburst identification for project NIMROD. Satellite and Mesometeorology Research Paper 156, University of Chicago, Department of Geophysical Sciences.



A severe windstorm took down many trees in this older stand of hemlock-hardwoods near Land O'Lakes, Vilas County. Though the damage is significant, important structural features created by events such as this include standing snags, large coarse woody debris, and tip-ups. Photo by Eric Epstein, Wisconsin DNR.



Forest tent caterpillar is a native leaf-eating species with outbreak cycles that generally begin every 6 to 16 years in northern Wisconsin. They defoliate the leaves of many broad-leaved trees and shrubs in northern Wisconsin, particularly aspen, oak, and birch. Photo by Shane Weber, Wisconsin DNR.

The extent and frequency of flood disturbance prior to Euro-American settlement is unknown. It is likely that flooding has now been reduced from historical levels due to a combination of stream channel downcutting and changes in bank structure that occurred during the early logging era as well as effects of dams and other water control structures. Reductions in the magnitude, duration, and timing of floods, which is needed for reproduction of some plants, limit seasonal inundation of floodplain forest and some other habitats and disrupt food webs in streams by allowing silt to accumulate on stream bottoms, thereby producing unfavorable habitat for some aquatic organisms.

Forest Insects and Diseases

The North Central Forest is a heterogeneous area due to the diverse physical environment caused by the last glaciation. It supports a wide variety of forest types, each of them associated with different insects and diseases. Thus, there are a number of species that can periodically affect forests in this ecological landscape. Aspen can be impacted by forest tent caterpillar (*Malacosoma disstria*), aspen heart rot fungus (*Phellinus tremulae*), and aspen hypoxylon canker fungus (*Hypoxylon mammatum*). White birch can be affected by bronze birch borer (*Agrilus anxius*), and drought can predispose the white birch to many diseases. Conifers, including red, eastern white, and jack pines and white spruce, can be affected by Annosum root rot, caused by the fungus *Heterobasidion annosum*, particularly in plantations. Red pines are also subject to **pocket mortality**, caused by a complex of insects and the fungal species *Leptographium terrebrantis* and *L. procerum*. Red pine is also susceptible to Diplodia pine blight fungus (*Diplodia pinea*) and pine sawfly (*Neodiprion* spp., *Diprion* spp.).

White pine blister rust is an introduced fungal disease caused by *Cronartium ribicola*; it is most severe in low-lying

areas. The jack pine budworm (*Choristoneura pinus*) is a native insect whose infestations can cause large-scale mortality of mature jack pine, setting up fuel conditions for catastrophic fire.

Gypsy moth (*Lymantria dispar*) is a nonnative insect, currently becoming established in this ecological landscape, that will periodically affect oak and aspen forests. The two-lined chestnut borer, *Agrilus bilineatus*, is a bark-boring insect that attacks oaks. Oak wilt is a vascular disease caused by the native fungus *Ceratocystis fagacearum*.

The spruce budworm (*Choristoneura fumiferana*) affects spruce (*Picea* spp.) and fir (*Abies* spp.) forests of the eastern United States and Canada (Kuceral and Orr 1981), with balsam fir being the most severely damaged by the spruce budworm. White and black spruce are suitable host trees, and some feeding may occur on tamarack, pine (*Pinus* spp.), and eastern hemlock. Spruce mixed with balsam fir is more likely to suffer budworm damage than spruce in pure stands. Periodic outbreaks of the spruce budworm are a part of the natural cycle of events associated with the maturing of balsam fir. Once a spruce budworm outbreak begins, it usually continues until the larvae consume much of the available foliage. Balsam fir is common throughout this ecological landscape, though at this time it is more important as a sapling or small tree than as a canopy species.

Eastern dwarf mistletoe (*Arceuthobium pusillum*) is a parasitic flowering plant that occurs in southeastern Canada, the northeastern U.S., and the upper Great Lakes states, including Wisconsin (Baker et al. 2006). It most often grows on and causes damage to black spruce. It seldom occurs on white spruce, likely because white spruce does not grow in pure stands. The common “witches broom” is the most obvious sign of an eastern dwarf mistletoe infection. Damage to black spruce includes reduced growth rates, reduced cone and seed production, increased susceptibility to drought, and



Dwarf mistletoe is a parasitic plant that sometimes infests stands of black spruce in northern Wisconsin peatlands. Photo by John Kohout.

increased attack by insects, fungi, and diseases. By taking food and water away from the host tree, this parasite reduces the amount of nutrients and water available for the tree's normal growth, defense mechanisms, and reproduction. Black spruce occurs throughout this ecological landscape and can be affected by eastern dwarf mistletoe.

Dutch elm disease is caused by the fungus (*Ophiostoma ulmi*), which is transmitted by two species of bark beetles or by root grafting. American elm (*Ulmus americana*) as well as other elm species are susceptible to this disease, which kills individual branches and eventually the entire tree within one to several years. Although Dutch elm disease is more common in southern Wisconsin, it is still a problem wherever elms occur in the North Central Forest.

Butternut canker is caused by a fungus (*Sirococcus clavigignenti-juglandacearum*) that is thought to have originated outside of the U.S. (Leisso and Hudelson 2008). It primarily affects butternut trees (*Juglans cinerea*) but is sometimes found on black walnut (*Juglans nigra*); however, it has little affect on that species. Butternut canker is found throughout the eastern U.S. wherever butternut trees occur and was first discovered in Wisconsin in 1967. The canker forms on tree trunks or branches and girdles the trunk or limb by cutting

off the supply of nutrients and water. It has killed up to 80% of all the butternut trees in some states. Butternut trees are more common in southern Wisconsin than in the north, but butternut canker is a problem in the North Central Forest wherever butternut trees are found.

The emerald ash borer is an exotic insect native to Asia. This extremely serious forest pest was known from 19 counties as of early 2014, and it likely occurs undetected in other locations. See the Wisconsin Emerald Ash Borer website (WDATCP 2013) for up-to-date information. A quarantine is now in place to limit the inadvertent spread of this insect, which may be present in ash (*Fraxinus* spp.) nursery stock, hardwood firewood, timber, or other articles that could spread emerald ash borer into other areas of Wisconsin or other states. Attempts to contain infestations in Michigan by destroying all of the ash trees in areas where emerald ash borer was found have been unsuccessful, perhaps because the insect was well established before it was found and identified. The emerald ash borer typically kills a tree within 1–3 years. In greenhouse tests, emerald ash borer has also been shown to feed on some shrub species such as privets (*Ligustrum* spp.) and lilacs (*Syringa* spp.), but it is still unknown as to whether shrub availability will contribute to its spread under field conditions. The emerald ash borer could have a great impact on forest composition and structure here. Black ash swamps are abundant in the North Central Forest and could be severely damaged by this exotic species.

More information about these diseases and insect pests of forest trees can be found at the Wisconsin DNR's forest health web page (WDNR 2013a) and at the U.S. Forest Service Northeastern Area forest health and economics web page (USFS 2014).

Invasive Species

Invasive species occur in the North Central Forest Ecological Landscape, but infestations are not generally yet severe. However, because recreational use is high and the North Central Forest receives many visitors from other regions of the state and country, this ecological landscape is vulnerable to the introduction and spread of invasive species. Human travel is a major vector for transport of a variety of invasive species, and tourism, recreation, and further development make this area ideal for initial introductions. Care needs to be taken to prevent the spread and introduction of invasive species.

In upland forests, common and glossy buckthorn (*Rhamnus cathartica* and *R. frangula*), nonnative honeysuckles (especially *Lonicera tatarica* and the hybrid *Lonicera x bella*), garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Dame's rocket (*Hesperis matronalis*), and black locust (*Robinia pseudoacacia*) already pose problems in some areas. Japanese knotweed (*Polygonum cuspidatum*) is also present in the North Central Forest Ecological Landscape. These species may initially colonize disturbed areas and edges but once established can continue to invade surrounding habitats, including forests.

In more open habitats, including roadsides, pastures, cutovers, and forest clearings, spotted knapweed (*Centaurea biebersteinii*), wild parsnip (*Pastinaca sativa*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), and common tansy (*Tanacetum vulgare*) are among the potentially problematic invasives already present.

In aquatic and wetland ecosystems, some of the major problem species are Eurasian water-milfoil, curly pondweed (*Potamogeton crispus*), common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), rusty crayfish (*Orconectes rusticus*), and reed canary grass (*Phalaris arundinacea*). Watercress (*Nasturtium officinale*), not always recognized as a potentially invasive species, is an exotic plant that can be locally dominant in springs and coldwater streams.

The relatively recent invasion of forests by nonnative earthworms is a major concern in this ecological landscape. While native earthworms were absent from northern Wisconsin following the last glaciation, nonnative earthworms have been introduced since Euro-American settlement, primarily as discarded fishing bait (Hendrix and Bohlen 2002, Hale et al. 2005). Nonnative earthworms can have dramatic impacts on the forest floor by greatly reducing organic matter (Hale et al. 2005), microbial biomass (Groffman et al. 2004), nutrient availability (Bohlen et al. 2004, Suarez et al. 2004), and fine-root biomass (Fisk et al. 2004). These physical changes to the forest floor reduce densities of tree seedlings and native (including rare) herbs (Gundale 2002) and can favor invasive plants (Kourtev et al. 1999).

Educational efforts have contributed to increased awareness of invasive species problems by government agencies and the public. Several organizations, including state and federal agencies, tribal resource management departments, and various nongovernmental organizations (NGOs), have conducted inventories of invasive species and mapped the locations of infestations. Two Cooperative Weed Management Associations are established in the North Central Forest to help public and private partnerships work more effectively across ownership boundaries to advance actions aimed at control of invasive species and to promote awareness among citizens. Control efforts have occurred all over this ecological landscape, but most notable are the biocontrol releases to combat infestations of leafy spurge, purple loosestrife, and spotted knapweed. For more information on invasive species, see the Wisconsin DNR's web page on invasive species (WDNR 2013b).

Land Use Impacts

■ **Historical Impacts.** Ecological impacts of large-scale logging and land uses in the latter half of the 19th century were immense in northern Wisconsin, and some of the effects persist to this day. After an almost complete removal of trees, extensive fires burned the slash and debris left by logging operations, consuming regenerating forests and removing the seed source for species that did not have effective means of vegetative reproduction. Access to forested lands and delivery of logs to sawmills were expedited by the network of waterways used



Earthworms are not native to Wisconsin and can create major problems in Wisconsin forests by altering soil conditions. The site depicted was reported to have had a lush ground layer five years before this photo was taken. Very few herbs are now present, and the forest floor is almost bare. Worms discarded by fishermen at a nearby lake are the possible source of this infestation. Lincoln County. Photo by Drew Feldkirchner, Wisconsin DNR.



Massive disturbance, exposure of bare soil. Eastern Vilas County. Photo by Eric Epstein, Wisconsin DNR.

to float logs to the mills. Riverways were cleared of large woody material to allow navigation, river bottoms and banks were scoured during log drives, and deposition of bark and other woody debris changed the character of many water bodies by smothering the river and stream bottoms and damaging or destroying in-stream habitat needed by fish and other aquatic organisms. Following the Cutover, the North Central Forest attracted settlers and agricultural activities, and railroad and road construction were widespread. Locally (e.g., in the Penokee Range), mining was an important land use. The forests of the ecological landscape have regenerated, but they are now composed of or dominated by different species and feature different age structures and patch sizes than those characteristic of the original forests (Schulte et al. 2007).

Many of these past land uses have left changes to the lands and waters that are still with us today. For example, due to past logging practices, there are now few older forests in the northern part of the state, and important conifers such as eastern hemlock and eastern white pine, with lesser amounts of white spruce, balsam fir, and northern white-cedar, are under-represented in the forest canopy. Most of the forests in the northern part of the state are now less than 100 years old. The morphology of some streams and rivers was changed when log drives scoured river bottoms. As bark fell off of the trees being floated down rivers to the mills, stream and lake bottoms were covered with bark changing the substrate of waterbodies. Parts of the denuded and charred landscape were susceptible to erosion, and water quality suffered as sediment-laden runoff increased. Dams built to generate hydropower created impoundments, which changed the character of the flowing waters to more closely resemble lakes. Many of the past attempts to farm failed, leaving old fields and an increase in hard edge across much of the ecological landscape. Many of these openings are slowly reverting to forest, but in some locations they are maintained to provide favorable habitat for game animals such as white-tailed deer.

■ **Current Impacts.** Disturbances in the current landscape are largely due to human activities, which include the long-term or permanent conversion of formerly forested land to roads, buildings, agricultural fields, and utility corridors. Shorter-term disturbances result from logging and recreational pursuits. Some effects are indirect, such as the high levels of browsing on saplings and shrubs by white-tailed deer, largely the result of human activities that have increased the size of white-tailed deer populations throughout much of the state. A major difference from natural disturbances is that today's impacts are multiple and pervasive, affecting much of the landscape almost constantly. Historically, most landscape ecosystems had disturbances that impacted portions of an area but typically moved around so that some areas remained undisturbed for long periods of time.

■ **Forest Management.** The focus on stand-level forest management at both the planning and implementation levels has resulted in the creation of many small to medium-sized patches with similar species composition and age-class structure. At the broader scale, there is loss of patch size variability and age-class diversity. Wildlife management practices have often encouraged the harvest of timber by clearcutting small patches (e.g., approximately 10 acres) of aspen to provide habitat for Ruffed Grouse and white-tailed deer. Developing local landscapes composed of small aspen patches with a variety of age and size classes has been considered ideal for these species, but it can limit habitat for many other species.

Numerous forest openings have been created and maintained as habitat for white-tailed deer and other wildlife. For example, Wisconsin DNR policy for state-managed lands as of this writing includes objectives for maintaining up to



Eastern hemlock seedlings on nurse log. In most parts of northern Wisconsin, browse pressure from white-tailed deer allows few young hemlocks to advance beyond this stage. Photo by Eric Epstein, Wisconsin DNR.



Even-aged stands of aspen are now maintained in many areas across northern Wisconsin, though age-class distribution has been an issue, along with stand size, configuration, and context. Photo by Steven Katovich, courtesy of U.S. Forest Service.



Logs harvested from a stand of mesic hardwood forest that contained relatively large trees and many cavity trees of low commercial but high ecological value. Broader planning considerations could have added important structural features to the forest adjoining an adjacent stand of swamp hardwoods under consideration for special management designation. Ashland County. Photo by Eric Epstein, Wisconsin DNR.



Numerous artificial openings have been created and maintained throughout the northern forests. The benefits go chiefly to species that are already widespread and abundant. Flambeau River State Forest. Photo by Joan Elias.

3% of the total land area in permanent herbaceous forest openings (McCaffery et al. 1981). There is also an objective to design clearings that provide up to 1% of the land area in herbaceous openings where none exists or to augment natural openings where they comprise less than half of the recommended composition. Although it has been shown to benefit white-tailed deer, creating artificial openings fragments areas of otherwise contiguous forest and provides an avenue for introducing invasive plants. Maintaining white-tailed deer populations at high levels can negatively affect native vegetation. Several species are especially sensitive to browse, including eastern hemlock, northern white-cedar, and Canada yew (*Taxus canadensis*) but also eastern white pine and other species such as yellow birch and understory species in the lily

and orchid families. White-tailed deer populations were often above stated goals in the 1990s and 2000s in the deer management units of the northern forest (see Figure 12.13), and only in 2008–13 have white-tailed deer populations been near or below goals in some deer management units.

Older forests were historically abundant but are now very rare in this ecological landscape. The creation of large amounts of edge habitats throughout most of northern Wisconsin has promoted habitat generalists at the expense of interior forest habitat specialists, area-sensitive species, and disturbance-sensitive species.

Ecological simplification and homogenization are taking place in mesic forests across northern Wisconsin. Past events (such as the Cutover) and current management practices have resulted in forests of similar composition, structure, and patch sizes in which a few species, such as sugar maple and quaking aspen, are now dominant. Conifers are absent, greatly diminished, or highly localized. This is especially true of eastern hemlock, a former dominant canopy species in much of northern Wisconsin, but eastern white pine, white spruce, and northern white-cedar also warrant mention with this group. Some important hardwood species, especially yellow birch, have also demonstrated serious declines. In recent decades, diseases have all but eliminated American elm and butternut as canopy species from the northern forests where they were minor but still locally important ecosystem components in some areas.

In addition to diminished (e.g., simplified) species representation in the forest canopy, large trees are now rare or absent, as are other key structural elements, such as large standing snags, *coarse woody debris*, and pit-and-mound microtopography. Recent studies have shown that some characteristic but more specialized and sensitive forest herbs, such as lilies, orchids, and insect-pollinated plants, are decreasing in abundance, while generalists and nonnatives are increasing (Rooney et al. 2004, Schulte et al. 2007). Impacts of high white-tailed deer populations, exotic earthworms, invasive plants, and diseases are exacerbating, and in some cases are at least partially responsible for the ecosystem simplification and homogenization that is occurring in Wisconsin's northern forests.

Strip cutting was implemented at a number of sites on federal lands in northeastern Wisconsin during the 1970s in an attempt to regenerate forested wetlands dominated by northern white-cedar. This was generally unsuccessful, often resulting in the conversion of northern white-cedar-dominated areas to thickets of deciduous shrubs. Northern white-cedar regeneration problems were exacerbated, habitat fragmentation and hard edge were increased, rare species habitat was lost, and northern white-cedar-dominated habitat was converted to other cover types. Strip cutting is also being used as a method to regenerate black spruce, with some success, but additional information is needed on the effects of this technique on some of the more sensitive and specialized plants and animals inhabiting acid conifer swamps.



Strip cutting has been used with mixed success to regenerate certain swamp conifers. For black spruce, this method had sometimes worked; for northern white-cedar, results in Wisconsin have often been very poor. In both cases, the technique creates a lot of hard edge and reduces the amount of mature forest needed by some habitat specialists. Left photo by Drew Feldkirchner, Wisconsin DNR; right photo courtesy of the National Agriculture Imagery Program, 2013.

The North Central Forest Ecological Landscape is probably Wisconsin's most important place in which to manage ephemeral ponds because they are abundant in some areas and many of the local watersheds around them have remained forested. Management guidelines and more effective protective measures are needed to increase awareness of their values, avoid isolating them from adjoining habitats, and prevent inadvertent damage.

Although plantations are somewhat less extensive in this ecological landscape than in others, the development of pine plantations, often converted from other cover types, creates patches of monotypic, structurally and compositionally simplified forests. Although there may be economic advantages to plantations, they are generally poor habitat for wildlife, including white-tailed deer (Kohn 1974), and seldom support diverse assemblages of native plants. There are some plantations of spruce on the Flambeau River State Forest and others in the Chequamegon-Nicolet National Forest that exhibit the same problems mentioned above, but occasionally these stands of planted conifers will support a few breeding boreal birds, such as the Cape May Warbler or Pine Siskin (*Spinus pinus*). Over the long-term, plantations need periodic maintenance and reestablishment, creating economic costs in addition to the ecological simplification they represent.

■ **Development.** In recent decades, the North Central Forest Ecological Landscape has experienced an influx of people. There has been an increase in both seasonal and permanent residents, creating a pattern of dispersed urbanization. This growth has increased both housing and road densities in this ecological landscape. Often, development first occurs in rings around lakeshores and then within the forests surrounding lakes. Parcelization and dispersed residential development in rural areas has fragmented contiguous habitats and ownerships, reducing their effective size and increasing land values and the costs of public services, contributed to

wildfire risks, and created long-term alterations in aquatic and terrestrial systems. Some of the ecological consequences of these factors associated with human activities include an increase in generalist species and nonnative habitats (e.g., roads, utility rights-of-way, lawns, landscaped areas, golf courses, sand blankets, sand and gravel quarries), feeding of wildlife, introduction of invasive plants, and predation by free-ranging dogs and cats. The placement of shoreline structures such as piers, boat lifts, and ramps can reduce the amount of nearshore aquatic habitat that benefit fish, invertebrates, and many wildlife species.

Lakeshore development has altered habitat conditions, affected water quality, and impacted some of the ecosystem functions of these aquatic systems. Shoreline development has resulted in a loss of aquatic and terrestrial plant cover for birds, fish, amphibians, and invertebrates. This has, in turn, caused a reduction in aquatic and terrestrial species diversity, favoring habitat generalists over more sensitive habitat specialists.

The ecological impacts of shoreline development have been documented in studies in northern Wisconsin and similar environments elsewhere in North America. In general, developed lakeshores take on a suburban quality, with areas of native vegetation and shoreline habitat replaced by manicured lawns. This may lead to excess nutrient runoff after lawn fertilization. Poorly managed construction sites on or near shorelines may also contribute sediment and other pollutants to lakes and streams. The removal of native vegetation decreases habitat values for mammals, birds, herptiles, fish, insects, and plants (Elias and Meyer 2003).

In the littoral, or shallow-water, zone of lakes, shoreline development has been associated with a number of negative impacts, including loss of desirable aquatic vegetation, reduction in diversity and productivity of fishes, loss of disturbance-sensitive fish, lower green frog (*Rana clamitans*) populations, loss of coarse woody debris (which creates important habitat for many fish and invertebrates), and **cumulative impacts**



Most of the larger lakes in Wisconsin are now developed for residential or other uses to at least some degree, altering habitat conditions and potentially impacting water quality. Photo by Jeff Martin.

whereby many small habitat losses or changes will ultimately have significant effects on the overall system.

Vegetative cover in littoral areas adjacent to developed shores was less abundant than along undeveloped shorelines along lakes in Minnesota (Radomski and Goeman 2001). On average, there was a 66% reduction in vegetation coverage with development. The estimated loss of emergent and floating-leaf macrophyte coverage from human development for all Minnesota's clear water panfish-walleye lakes was 20–28%. Significant positive correlations were detected between occurrence of emergent and floating-leaf plant species and relative biomass and mean size of northern pike, bluegill, and pumpkinseed (*Lepomis gibbosus*). Current shoreline regulatory policies and landowner education programs may need to be changed to address cumulative impacts to North American lakes.

Environmental changes due to shoreline development include increased runoff and decreased water quality, wildlife habitat, and natural scenic beauty. Undeveloped **shorelands** serve as **buffers** to runoff because it prevents water, along with associated pollutants and nutrients, from flowing directly into lakes. With developed shoreland there is little opportunity to filter or infiltrate pollutants and nutrients from shoreland sources because they move unimpeded into surface waters. Controlling lot size and width and the extent and location of impervious surfaces are important means of decreasing cumulative negative environmental impacts.

Mitigating the adverse effects after shoreline development has occurred can reduce the impact of impervious surfaces and compacted soils. However, it is important to realize that mitigation techniques can be expensive and difficult to consistently implement and maintain, and it may not be as effective as the original shoreline habitat. The negative impacts of high density development and the related increase in impervious surfaces can be mitigated to some extent by local zoning

regulations that could require low impact design, including minimizing impervious surfaces, avoiding or reducing soil compaction, installing stormwater ponds, leaving shoreline buffers, seeding and mulching construction sites, and reducing or avoiding application of fertilizers.

A few pollution or disturbance-intolerant or specialist fishes have declined in distribution and abundance in these lakes because of environmental degradation of the littoral zone, replaced by greater numbers of more tolerant or habitat generalist species that have been spread by resource management agencies and anglers. Some stresses, such as the introduction of competing species—such as white sucker (*Catostomus commersonii*), which eats brook trout eggs—can suppress populations of the highly desired trout.

Another impact of lakeshore development and certain types of management for the resultant heavy recreational fishing is homogenization of the fish fauna (Rahel 2000). Loss of littoral zone aquatic vegetation reduces aquatic invertebrate food base production and decreases important fish nursery and foraging habitat (Radomski and Goeman 2001). This prompts calls for augmenting loss of natural fish production by stocking. Many fish species that are native to the waters of the North Central Forest but were limited historically to certain waters now have a much wider distribution through both legal and illegal stockings and bait bucket releases. Examples include most game fish and panfish, such as walleye, largemouth bass, and bluegill, and many **nongame** fishes used as bait, such as fathead minnow (*Pimephales promelas*) and golden shiner (*Notemigonus crysoleucas*). Fish species richness in many lakes is now correlated with degree of accessibility, and lakes with formerly distinctive fish faunas are now more homogenous (Rahel 2000, Gaumnitz 2005).

Another recent driver of disturbance has been a significant shift in land ownership as large industrial forest holdings have been sold, either to other industrial owners, developers, or private individuals. Between 1997 and 2002, more than 94% of Wisconsin's private industrial forest, about 1 million acres, changed ownership (TNC 2006). From 1999 to 2007, enrollment of industrial forestland acreage held by large owners in the Wisconsin Forest Tax Law Program declined by 17% (TNC 2013a). Creating smaller parcels from these holdings will add to habitat fragmentation, habitat loss, and potential decreases in water quality. Many of these properties have historically been used for recreation by the public under state forest tax law programs. This change in ownership may reduce the amount of land open to the public for recreation and increase recreational pressure on the public land base. If not sold to other industrial owners and managers, this will likely decrease the volume of wood products formerly coming from these areas, again increasing pressure to harvest elsewhere—especially on the public lands. Only a small proportion of these industrial lands have gone into public ownership (Wisconsin Legislative Council 2010) or into projects maintaining both public access and forest products industry jobs, such as the Wild Rivers Legacy Forest (TNC 2013b).



The fragile, silty soils of this floristically rich mesic hardwood forest suffered severe rutting during an ill-timed and poorly executed logging operation. The soils were badly compacted, rare plant habitat was damaged, and the ruts channeled water, which led to the downslope deposition of sediments into wetlands and streams. Ice-walled lake plain near the Yellow River, Taylor County. Photo by Eric Epstein, Wisconsin DNR.

■ **Changes in Hydrology.** Changes to hydrology from road construction and other developments has eliminated some wetlands and degraded others in this ecological landscape. The loss of wetlands can have negative impacts on aquatic communities due to increased inputs of sediments, pollutants, and pesticides.

Conversion of bog, fen, muskeg, or sedge meadow to open marsh diminishes the amount of natural habitat available for native peatland species and can have ecological impacts on the entire peatland ecosystem and the species that depend on them. Type conversions such as this may create additional management costs and challenges in the future if not planned and implemented within a framework of broadscale habitat considerations.

Dams have raised water levels and affected wetlands in some sites in this ecological landscape but created marsh habitat in locations further upstream. Dams constructed for hydropower have fragmented rivers, altering and ultimately degrading stream and river characteristics. Fish and other aquatic species are restricted in their movements to river reaches either below or above dams. Water-level manipulation activities at dams can affect species both upstream and downstream from the dam. For example, nesting aquatic birds can have their nests flooded upstream if water levels are raised too high during the nesting season. Aquatic species living below dams can be left without enough water to survive cold temperatures if water is being stored during critical winter periods. Hydrologic alterations of many of our major rivers due to dam and impoundment construction have changed the frequency, timing, magnitude, and duration of flood events, casting uncertainty on long-term response of the floodplain vegetation.

Management Opportunities for Important Ecological Features of the North Central Forest

Natural communities, waterbodies, and significant habitats for native plants and animals have been grouped together as “ecological features” and identified as management opportunities when they

- occur together in close proximity, especially in repeatable patterns representative of a particular ecological landscape or group of ecological landscapes;
- offer compositional, structural, and functional attributes that are important for a variety of reasons and that may not necessarily be represented in a single stand;
- represent outstanding examples of natural features characteristic of a given ecological landscape;
- are adapted to and somewhat dependent on similar disturbance regimes;
- share hydrological linkage;
- increase the effective conservation area of a planning area or management unit, reduce excessive edge or other negative impacts, and/or connect otherwise isolated patches of similar habitat;
- potentially increase ecological viability when environmental or land use changes occur by including environmental gradients and connectivity among other important management considerations;
- accommodate species needing large areas or those requiring more than one habitat;
- add habitat diversity that would otherwise not be present or maintained; and
- provide economies of scale for land and water managers.

A site’s conservation potential may go unrecognized and unrealized when individual stands and habitat patches are managed as stand-alone entities. A landscape-scale approach that considers context and history of an area along with the types of communities, habitats, and species that are present, may provide the most benefits over the longest period of time. This does not imply that all of the communities and habitats associated with a given opportunity should be managed in the same way, at the same time, or at the same scale. Instead we suggest that planning and management efforts incorporate broad considerations that address vegetation scale and structure that approximate the *natural range of variability* in an ecological landscape—especially those that are missing, declining, isolated, or at the greatest risk of disappearing over time.

Both ecological and socioeconomic factors were considered when determining management opportunities. Integrating ecosystem management with socioeconomic activities

can result in efficiencies in the use of land, tax revenues, and private capital. This type of integration can also help to generate broader and deeper support for sustainable ecosystem management. Statewide integrated opportunities can be found in Chapter 6, “Wisconsin’s Ecological Features and Opportunities for Management.”

Significant ecological management opportunities that have been identified for the North Central Forest include

- Northern Mesic Forest: the vegetation matrix of the North Central Forest Ecological Landscape
- Wet-mesic Forests (Northern Wet-mesic Forest and Hardwood Swamp)
- Northern Wet Forest (Black Spruce Swamp and Tamarack Swamp)
- Northern Dry-mesic Forest (eastern white and red pine forests)

- Herbaceous and shrub-dominated wetlands (including open peatlands)
- Forested watersheds and headwaters of important rivers and lakes
- Ephemeral ponds
- Bedrock features
- Glacial features

Natural communities, community complexes, and important habitats for which there are management opportunities in this ecological landscape are listed in Table 12.3. Examples of some locations where these important ecological places may be found within the North Central Forest Ecological Landscape are on the map entitled “Ecologically Significant Places of the North Central Forest Ecological Landscape” in Appendix 12.K at the end of this chapter.

Outstanding Ecological Opportunities in the North Central Forest Ecological Landscape

- The North Central Forest offers the state’s best opportunity to manage for and maintain interior forest conditions at large scales.
- Northern Mesic Forest makes up the ecological matrix within which other natural communities and aquatic features are embedded.
- This ecological landscape may be a “source area” for many forest interior species, aquatic species, and habitat specialists.
- Glacial landforms are well represented here and include ground and end moraines, outwash plains, drumlins, eskers, ice-walled lake plains, and water gaps. Each of these is associated with a mosaic of characteristic vegetation, aquatic features, species assemblages, and conservation opportunities.
- Watersheds are characterized by high forest cover, a factor that contributes greatly to high water quality and the ability of this area’s lakes and streams to support sensitive aquatic life.
- The headwaters or other important stretches of major river systems, including the Wisconsin, Chippewa, Flambeau, Black, Pine, Popple, Oconto, and Wolf, are embedded within the extensive forests of the North Central Forest.
- Diversification of forest patch sizes, structure, and composition can be accomplished via integrated and coordinated planning, restoration, and a broad approach to management.
- Among the diminished forest attributes are large patches of interior forest, old-growth and old forests and their associated structural features, representation of conifers such as eastern hemlock, eastern white pine, northern white-cedar, and Canada yew, and connections within and across ecological landscapes.
- Lakes are unevenly distributed but common on certain landforms. They provide critical habitat for aquatic and other water-dependent organisms.
- Swamps dominated by northern white-cedar or black ash are more common here than anywhere else in the state.
- Acid peatlands (bog, poor fen, Muskeg, and black spruce-tamarack forest) are common, widespread, and in generally good condition.
- Ephemeral ponds are locally common in areas of low relief, fine-textured soils, and impeded drainage.
- Wild rice is more common here than anywhere else in the state.
- The large public land base (44% of the North Central Forest, 2,687,309 acres) is a major contributor to ecological, recreational, and economic opportunities. Federal, state, and county ownerships are all significant here.
- Extensive private holdings include tribal lands, industrial forests, and conservation projects by NGOs.

Table 12.3. Natural communities, aquatic features, and selected habitats associated with each ecological feature within the North Central Forest Ecological Landscape.

Ecological features ^a	Natural communities, ^b aquatic features, and selected habitats
Matrix of northern hardwood/hemlock forest	Northern Mesic Forest (virtually all communities and habitats listed elsewhere in this table occur somewhere within and are influenced by the mesic matrix forest)
Northern Wet-mesic Forests: Northern White-cedar Swamp	Northern Wet-mesic Forest Northern Hardwood Swamp Springs and Spring Runs – Hard Springs and Spring Runs – Soft
Northern Wet Forests: Black Spruce Swamp; Tamarack (Poor) Swamp	Northern Wet Forest
Eastern white and red pine forests	Northern Dry-mesic Forest
Herbaceous and shrub wetlands	Alder Thicket Boreal (Rich) Fen Emergent Marsh Emergent Marsh-Wild Rice Floating-leaved Marsh Northern Sedge Meadow Open Bog/Muskeg Poor Fen Shrub-carr Submergent Marsh
Rivers, streams, lakes and ponds their forested watersheds	Inland Lake Seepage Lake Drainage Lake Drained Lake Meromictic Lake Spring Pond Soft Bog Coldwater Stream Coolwater Stream Warmwater River Warmwater Stream
Ephemeral ponds	Ephemeral Pond
Bedrock features	Bedrock Glade Dry Cliff Felsenmeer Rock Gorge Moist Cliff Talus Slope Waterfall
Miscellaneous opportunities	Boreal Forest Bracken Grassland Dry-mesic Forest Northern Dry Forest Rare species populations

^aAn “ecological feature” is a natural community or group of natural communities or other significant habitats that occur in close proximity and may be affected by similar natural disturbances or interdependent in some other way. Ecological features were defined as management opportunities because individual natural communities often occur as part of a continuum (e.g., prairie to savanna to woodland) or characteristically occur within a group of interacting community types (e.g., lakes within a forested matrix) that for some purposes can more effectively be planned and managed together rather than as separate entities. This does not imply that management actions for the individual communities or habitats are the same.

^bSee Chapter 7, “Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin,” for definitions of natural community types.

Northern Mesic Forest: The Vegetation Matrix of the North Central Forest Ecological Landscape

The North Central Forest was historically covered by vast forests, with mesic northern hardwoods and hemlock-hardwoods being the most abundant forest communities by far. Today the North Central Forest is one of Wisconsin's very few landscapes that remains dominated by vegetation that broadly resembles what was present prior to settlement of the Upper Midwest by Euro-Americans. This ecological landscape was heavily forested then, as it is now.

From the mid-1800s through the early 1900s, virtually all of this forest was heavily cut, and much of it was also severely burned. Some areas burned repeatedly. The composition and age structure of the northern forests were dramatically altered, with eastern hemlock virtually disappearing from many areas in which it had previously been dominant, and important trees such as yellow birch and eastern white pine greatly reduced in abundance. The major canopy increasers following the Cutover included trembling aspen, white birch, and sugar maple. The old-growth forests that characterized much of this ecological landscape historically are all but gone, persisting only as widely scattered remnants of a few hundred acres at most.

Much of the North Central Forest Ecological Forest remains forested; the public lands are extensive, concentrated, and often adjoin one another. There are also significant acreages of forested tribal and industrial lands, and several NGOs have major projects in the North Central Forest. Examples of the latter include The Nature Conservancy's "Border Lakes" project in north central Vilas County on the Wisconsin-Michigan border; the "Wolters Tract," a complex of several thousand acres of forest and several undeveloped lakes in northwest Vilas County; and "Caroline Lake," a project centered on a large undeveloped lake surrounded by extensive second-growth mixed conifer-hardwood forest on the Ashland-Iron county line. All of these projects involve partnerships with various government agencies, NGOs, and others. Innovative forest management practices are being implemented at Caroline Lake and at several other sites.

Opportunities exist to maintain or restore important ecological features and provide for connectivity with other ecological landscapes. For the foreseeable future, much of the North Central Forest will remain a "working forest" landscape, which will be managed to provide an array of ecological and social benefits. The "homogenization" of the northern forest landscapes in the western Great Lakes region (Schulte et al. 2007) and the resulting loss of important forest community features and functions is of great concern to managers and conservationists.

Management Opportunities, Needs, and Actions

- The North Central Forest Ecological Landscape offers the state's best opportunities to maintain or recreate large blocks of interior forest. The present range of patch sizes, size and



Old-growth forest remnant dominated by large eastern hemlock, yellow birch, and sugar maple. Eastern hemlock is reproducing well in this stand. Patterson Hemlocks State Natural Area, Oneida County. Photo by Eric Epstein, Wisconsin DNR.



Forested landscape dominated by northern hardwoods but with pockets of aspen, conifers, wetlands, and aquatic features. Flambeau River State Forest, Sawyer County. Photo by Eric Epstein, Wisconsin DNR.



Lush layer of Canada yew under sugar maple pole timber near the Montreal River, Iron County. This stand contained several ephemeral ponds. Photo by Eric Epstein, Wisconsin DNR.



Undeveloped creek, shrub swamp, swamp hardwoods, and the extensive mesic forests of the Penokee-Gogebic Iron Range. Iron County. Photo by Eric Epstein, Wisconsin DNR.

age class representation, and species composition are considerably outside of the natural range of variability for the mesic forests of the Great Lakes states (Padley and Strong 2004). Young and medium-aged forests of a small number of cover types are emphasized, especially in the management of county and industrial forests but on state and federal lands as well. At larger scales, the representation and potential restoration of diminished compositional and structural features can be addressed on state and federal forests.

- The restoration of missing patch sizes, structural features, successional stages, and habitat specialists can be accomplished to varying degrees on different ownerships via integrated and coordinated planning. Restoration needs and opportunities may vary by forest community type, geographic location, land use history, or ownership as well as due to many social factors.
- Formerly important forest species needing increased representation include eastern hemlock, eastern white pine, yellow birch, northern white-cedar, Canada yew, and on the eastern edge of the North Central Forest Ecological

Landscape, American beech (*Fagus grandifolia*). The management of northern red oak, especially on more mesic sites, is as problematic here as it is in other parts of Wisconsin. All of our native ashes are vulnerable to attack by the emerald ash borer.

- Local governments, tribes, industry, NGOs, and private individuals all own lands on which some of these objectives can be achieved, albeit at widely varying scales. **Forest certification** may provide an incentive to accomplish some of these goals, but incentives that are not primarily economic are also needed.
- Connecting large forest blocks to one another and to extensive forested areas in other ecological landscapes is an important management consideration. Complicating factors and challenges include multiple administrative jurisdictions, different ownerships and mandates, and traditions. Providing for the population viability and dispersal of native plants and animals will be key future management considerations to avoid population isolation and potential loss of species in the face of environmental change and human population growth.
- Forests representing rare successional or developmental stages, demonstrating unusual composition, or that support populations of rare or otherwise sensitive species should be recognized as candidates for special designation and management modified as feasible to ensure that these features are increased or maintained. If such forests cannot be represented at a large scale, manage adjoining lands in such a way that the rare or uncommon attributes of these stands are maintained or enhanced—not compromised and ultimately lost. Context and compatibility then become important management considerations.
- “Working forests” can provide suitable habitat for many, but not all, forest-dependent plants and animals. Expand the managers’ toolkit by providing additional guidance on the needs of sensitive species, the restoration of missing structures and species, and how these goals might be achieved by adjusting management to include additional management classes. Recent iterations of several Wisconsin DNR handbooks, including the *Old-growth and Old Forests Handbook* (WDNR 2006a), include some information that addresses these issues for managers. **Relict** stands of old-growth are all but absent from the state. Older forests, with trees older than 120 years, are also rare, especially upland stands with structural attributes such as trees with a range of diameter sizes including very large sizes, large-diameter coarse woody debris, large living and dead snags and den trees, and pit-and-mound microtopography. The North Central Forest Ecological Landscape offers excellent opportunities to manage areas for older forest within a context of outstanding aquatic features, intact wetlands, and vast, sometimes adjoining, public landholdings.

- As of this writing, over 7 million acres of forested land in Wisconsin are certified by one or some combination of three independent certification systems: the Forest Stewardship Council (FSC), the Sustainable Forestry Initiative (SFI), or the American Tree Farm System. In exchange for agreeing to follow certain management guidelines, the landowner has access to markets that would otherwise be unavailable. These systems have several ecologically based principles and criteria, including consideration for rare species and areas of conservation importance. In particular, the Forest Stewardship Council includes a principle for the maintenance of high conservation value forests (FSC 2010).
- Limit or discontinue the wildlife openings program in areas already possessing high (i.e., over goal) white-tailed deer populations and that contain species or habitats sensitive to excessive browse pressure. Identify areas with relatively low white-tailed deer populations, little aspen, and low amounts of hard edge, and maintain and monitor them where possible.
- Protect watersheds around lakes, stream headwaters, and wetlands by maintaining a high percentage of forest cover, avoiding exposure of bare soil on steep or otherwise highly erodible slopes, providing for hydrologic integrity, discouraging developments that are incompatible with maintaining high water quality and sufficient water quantity, and using *best management practices* (BMPs). Focus on the protection of those waterbodies that occur in headwaters areas, have undeveloped forested watersheds, support exceptional diversity, or contain viable populations of rare species. Restoration of damaged or disturbed waterbodies and watersheds is a secondary focus that could be prioritized using the same criteria mentioned above but factoring in economics, feasibility, and range of partners. Offer extra protection to the natural ecotones at the water-wetland-upland interfaces and to sites supporting rare species or natural communities.
- Eastern white and, rarely, red pines were long-lived and important structural and compositional components of mesic forests in this ecological landscape. There are opportunities, albeit limited, to restore and/or maintain pine as a component of the mesic forests here. Dry-mesic pine forests do occur in the North Central Forest, and although they are relatively rare, can provide habitat and structure used (in some cases needed) by forest dwelling animals, including some that are rare or sensitive. Protection and maintenance of existing pine forests will retain a seed source for reintroduction into nearby mesic forests, increase conifer cover in areas from which conifers have been removed or depleted, and provide a wide range of social benefits.
- Stands of upland boreal conifers (white spruce and/or balsam fir) are uncommon but occur as scattered small groves across the northern parts of the North Central Forest Ecological Landscape. Where these stands adjoin coniferous wetlands or other upland forest communities with a significant component of eastern hemlock or pine, there may be good potential to retain or increase habitat for conifer-dependent wildlife, including some of the boreal specialists such as Cape May Warbler, Evening Grosbeak, Pine Siskin, Red Crossbill, and White-winged Crossbill (*Loxia leucoptera*).
- Opportunities to embed patches of eastern white (and red) pine forest and boreal spruce-fir forest within the much more extensive matrix of Northern Mesic Forest are extremely important for many species of northern forest wildlife strongly associated with or dependent on conifers and adds structural and compositional features that contribute to landscape diversity.
- Support research on natural disturbance events; modify management as appropriate to ensure that key processes, structures, and niches are maintained.
- Develop and provide materials that will help forest managers recognize signs of damage due to overabundant white-tailed deer, infestations of nonnative earthworms, and invasive plants. Develop appropriate *adaptive management* strategies when these problems are evident and understood. The document *Wisconsin's Forestry Best Management Practices for Invasive Species* is designed to help slow the spread of invasives during management activities and is available on the Wisconsin Council on Forestry website (WCOF 2009).
- Identify an expanded suite of northern forest plants, animals, and habitats to monitor at selected sites (actively managed and passively managed sites) that include forest herbs and lichens, invertebrates, herptiles, birds not covered by existing surveys, and mammals. Implementation of Wisconsin's Wildlife Action Plan (WDNR 2008b) may be one means of doing this.
- Clarify the key role that restoration must play to meet certain opportunities in forest management. Additional information is needed to develop sound and practical methodologies that will achieve forest restoration goals such as restoring conifers and yellow birch, restoring important forest structural features, effectively dealing with high white-tailed deer populations, and identifying and protecting areas free from nonnative earthworms.
- Several research projects are underway that are examining various aspects of forest restoration, including ecological and economic factors associated with old-growth forest.
- Identify and map areas that are not yet infested with nonnative earthworms. Manage nearby roads and other travelways and corridors to minimize the dispersal of earthworms via vehicles. Design monitoring programs to establish baselines to describe stands that haven't been impacted. Identify infested stands and compare them with noninfested stands.

Wet-Mesic Forests (Northern Wet-Mesic Forest and Hardwood Swamp)

Collectively, wet-mesic forests, including Northern Wet-mesic Forest (northern white-cedar-dominated conifer swamps), and Hardwood Swamp (black ash-dominated hardwood swamps), are more common in the North Central Forest Ecological Landscape than anywhere else in the state. Northern white-cedar is the dominant tree in the coniferous wet-mesic forests, which sometimes develop on peaty substrates that receive input from mineral-enriched groundwater. Seepages, springs, and spring runs are characteristic features of many northern white-cedar swamps. For decades northern white-cedar reproduction has been adversely impacted by excessive browse pressure from white-tailed deer to the point that reproductive failure by northern white-cedar is now the norm across most of northern Wisconsin. Northern white-cedar's longevity allows this community type to persist at present, but the problem of northern white-cedar's reproductive failure needs resolution if the community type is to be maintained. Maintaining the viability of the northern white-cedar swamps is of paramount importance in the North Central Forest because the community is common and widespread there and constitutes a major repository of biodiversity for rare plants and some animals.



Northern white-cedar swamps provide habitat for numerous rare plants and animals. Major threats are posed by hydrologic disruption and excessive browse pressure on young cedar by white-tailed deer. Photo by Drew Feldkirchner, Wisconsin DNR.

Ash-dominated wet-mesic forests ("Hardwood Swamp" in the Wisconsin Natural Heritage Working List) have been poorly studied in Wisconsin and were not recognized here as distinct natural communities by ecologists until recently. Black ash swamps occur in a variety of poorly drained basins. Soils are often mucks, and pools of standing water are common features, especially following spring snowmelt. The ashes (black ash is usually dominant, sometimes to the virtual exclusion of all other tree species) are sensitive to hydrologic disruption and growing season frosts. The potential threat posed by the entry into Wisconsin of the exotic insect, emerald ash borer, is highly significant. Dutch elm disease has already eliminated the native elms (*Ulmus* spp.) as significant canopy species from almost all lowland hardwood forests, just as they were eliminated from upland forests and urban areas, throughout Wisconsin.

Wet-mesic forests of eastern hemlock, yellow birch, and northern white-cedar were apparently common in parts of the North Central Forest historically, but many of them did not recover from the heavy logging and slash fires that occurred in the north during the Cutover. More recently, increased population levels of white-tailed deer has exacerbated the potential recovery of browse sensitive species such as eastern hemlock, northern white-cedar, Canada yew, and certain forest herbs.

Management Opportunities, Needs, and Actions

- Identify significant sites containing northern white-cedar or black ash swamps throughout the North Central Forest via field inventory. Use the public lands planning process or forest certification to recognize the existing or potential significance of sites supporting good examples of this community and designate them appropriately in specific property planning documents.
- Protect site hydrology wherever northern white-cedar swamps occur. Wet-mesic forests are sensitive to hydrologic alterations. Restoration techniques are unproven at best and will almost certainly involve more than plugging a ditch or unplugging a culvert. Spring-fed northern white-cedar swamps are vulnerable to inundation and the death of trees due to construction of dams by American beaver.
- Discourage or end the practice of "managing" northern white-cedar swamps as winter white-tailed deer yards. It is destructive and ultimately unsustainable. The short-term benefits lead to long-term damage and chronic problems, which will only become worse in the future.
- Strip cutting was widely implemented as a method of regenerating northern white-cedar in the northeastern part of the ecological landscape several decades ago. Without exception these attempts were unsuccessful, and the practice should be discontinued. In the future, more reliable and less destructive methods of northern white-cedar regeneration may be developed, but at this time they do not exist. Impacts on the herbaceous layer from strip cutting have not been investigated or well documented in Wisconsin.

Significant concerns remain with this technique because of the negative impacts of habitat fragmentation, the creation of excessive amounts of forest edge in a type that is highly sensitive to browse damage from white-tailed deer (and in some cases, from snowshoe hare), disruption of site hydrology, loss of those stand conditions upon which rare species are dependent (e.g., high canopy closure and shade, high internal humidity), rutting from heavy equipment, and the potential for spread of invasive species such as glossy buckthorn and European swamp thistle (*Cirsium palustre*).

- Management of the lands around northern white-cedar swamps, especially those that have been identified as conservation priorities because of their size, structure, disturbance history, or high biodiversity values, needs to be done in a way that recognizes their vulnerability to damage when adjacent uplands are managed to promote early successional habitats—especially aspen. In such situations, stand-level planning is not adequate to ensure the long-term viability of the northern white-cedar community.
- Plan to avoid creating small, isolated islands of northern white-cedar or eastern hemlock forest surrounded by or adjacent to areas receiving intensive management to regenerate aspen and/or increase white-tailed deer populations. More attention to the contextual consequences of management is needed.
- More knowledge of the condition, composition, structure, and function of black ash swamps is needed throughout the Wisconsin range of this community. Information is needed soon to ensure that this community type is sustained.
- Black ash swamps statewide need to be monitored closely to detect the presence of emerald ash borer as early as possible. Now that emerald ash borer has been found in Wisconsin, an accelerated research program aimed at developing integrated control methods should be a top priority.
- Restoration methods need to be developed for both northern white-cedar and black ash swamps, especially for sites with past hydrologic disturbance.
- Forested wetlands may occur as isolated communities but are more often integral components of complex vegetation mosaics within the same wetland basin. All of the wetland vegetation within a basin should be considered and its management planned for in an integrated and coordinated fashion rather than as separate communities or independent management units. Upland forests adjoining conifer swamps need to be managed compatibly with maintaining or enhancing the sensitive attributes of the swamps.

Northern Wet Forest (Black Spruce and Tamarack Swamps)

In recent years, the broad plant community referred to by Curtis (1959) as “Northern Wet Forest” has been broken down into two basic types of conifer swamp: the boggy and highly

acidic “Black Spruce Swamp” and the more minerotrophic “Tamarack (Poor) Swamp” (see Chapter 7, “Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin,” for descriptions of each community type). Both are common and widely distributed across the North Central Forest. These forests develop on acid, peaty substrates throughout the ecological landscape, and until recently, for a variety of reasons (including the low value of the trees and the costs involved in extracting timber from remote wetlands), many stands had been left alone. Increased utilization of these conifer swamps may occur in the future. The problems associated with using such forests for commercial purposes include economics, low volume of wood, the extremely slow growth rate exhibited by trees on many sites, lack of basic inventory information, hydrologic sensitivity, accessibility, impacts on rare species and their habitats, and slow recovery of these forest communities at the latitude of Wisconsin. Sustainability may be a significant issue here. In addition to concerns over sustainability and loss of habitat for specialists, subjecting the forested peatlands to increased disturbance may exacerbate the release of carbon into the atmosphere.

The Wisconsin DNR’s “Peatlands Project” (Anderson et al. 2008a) provides recent data on taxa associated with Wisconsin’s peatland ecosystems, including rare species from several taxonomic groups, and the potential influence of future climate change on peatland communities, plants, and animals.

Large, hydrologically intact sites occur on many public lands throughout the North Central Forest. Examples are included on the “Ecologically Significant Places of the North Central Forest” map in Appendix 12.K at the end of this chapter.

Management Opportunities, Needs, and Actions

- Protect site hydrology; the communities and many of their most sensitive plant and animal components are less likely to persist if this is not the first consideration.



This mature conifer swamp in Iron County features a canopy of black spruce over an understory of Labrador tea and hummocky sphagnum mosses. Such communities provide critical habitat for specialized boreal animals, especially birds and invertebrates. Photo by Loren Ayers, Wisconsin DNR.

- Identify sites throughout the North Central Forest that are large, have good potential to maintain or recover lost or diminished cover types (e.g., tamarack) and forest developmental stages, and support populations of sensitive species. Propose management options to landowners, planners, and managers.
- Identify corridors that connect large blocks of contiguous forest, especially of coniferous forest types, and develop strategies to maintain or restore them.
- Avoid isolating small stands of swamp conifers in areas where adjacent uplands are receiving intensive management. Roads, log landings, and other infrastructure need to be located to avoid fragmenting swamp conifer stands, disrupting hydrology, or disrupting the movements of species that use different habitats at various stages of their life cycles.
- The Wisconsin DNR's "Peatlands Project" (Anderson et al. 2008a) was completed in 2008 and includes information on peatland ecology, natural communities, rare and representative species populations, management considerations and threats, and site-based protection needs and opportunities.
- More information is needed on the composition, structure, and function of swamp conifer communities. Develop reliable restoration and management guidelines prior to increasing utilization of swamp conifers, especially older stands that support rare or otherwise sensitive species. The concept of "swamp conifers" is broad and cannot encompass the variety of approaches to management and protection that will be required to maintain and/or protect them over time.

Northern Dry-Mesic Forests (Eastern White and Red Pine Forests)

Northern Dry-mesic Forest has a limited distribution in this ecological landscape but does occur locally on some landforms, such as coarse-textured end moraines, outwash, or in areas with thin, rocky, drought-prone soils. Stands of pine add significantly to diversification of the natural community mosaic. The pines, because of their capability for attaining great size and branching pattern, add structure not provided by other trees (including other conifers), provide habitat for forest raptors and some colonial birds, and support animals dependent on or strongly associated with cone-bearing trees. Dead pines may persist as snags or down trunks for many decades and are an important potential source of large coarse woody debris, an important forest feature that is now missing from many managed forests.

Historically, eastern white pine and, more rarely, red pine sometimes occurred as widely scattered, very large individuals within more mesic forests. Heavy logging, *high grading*, and subsequent slash fires have led to the loss of seed source, and altered disturbance regimes have combined to prevent

the pines from maintaining or reestablishing their former roles in the mesic forests of the North Central Forest Ecological Landscape. Restoration and management of the pines will be extremely challenging but may be possible in some areas. Mesic remnants with a eastern white (or red) pine supercanopy are now rare and becoming scarcer each year (and nothing is replacing those trees that are being lost). Identify remaining stands, sample them if possible, and assess maintenance and restoration potential (we would expect restoration potential to be low in a majority of cases, but there may be exceptions). Restoration of this component of the mesic forests might best occur or be attempted within disturbed forests, rather than within the very few remaining old-growth, structurally complex remnants.

Management Opportunities, Needs, and Actions

- The best opportunities occur locally, on rocky slopes, outwash plains, coarse-textured end moraines, or some shorelines. Stands of eastern white and/or red pine-dominated dry-mesic forest are of high value to many wildlife species and for other reasons (e.g., they create habitat features not provided by other tree species, increase the coniferous canopy component, and provide thermal cover during harsh weather).
- Natural pine forests have declined tremendously throughout Wisconsin and warrant increased protection and restorative management attention, wherever they still occur.
- Stands of pine-dominated dry-mesic forest that are associated with other types of coniferous forest, e.g., hemlock-hardwoods, northern white-cedar swamp, black spruce swamp, tamarack swamp, or boreal forest, will have the greatest value to conifer-dependent wildlife and add the potential of supporting species, especially animals, that would otherwise not be present (e.g., area sensitive species or birds that specialize in feeding on conifer cones).
- Pine forests were historically dependent on periodic wildfire, yet they did occur as inclusions within an almost fire-proof landscape. On certain sites, under certain conditions, there may be opportunities to add the use of prescribed fire to the site stewards' available management tools.
- Management of eastern white (or red) pine as even a limited component of mesic forests will be very difficult but might be attempted at certain locations where the chances of success are relatively high and the benefits compatible with other important management goals.

Herbaceous and Shrub-Dominated Wetlands (Including Open Peatlands)

Shrub swamps are common along streams, lake edges, and the margins of open wetlands. Alder Thicket is by far the most common and broadly distributed native shrub community in the North Central Forest Ecological Landscape and provides

excellent habitat for a wide range of plants and animals. Species of management concern due to rarity, declining populations, or importance as game animals include wood turtle, Golden-winged Warbler, American Woodcock, and snowshoe hare all make use of tall shrub communities, especially Alder Thicket. Shrub swamps composed of mixtures of willows, dogwoods, and other tall shrubs (the “Shrub-carr” community) are present at some locations and occur in extensive stands in a few areas.

Sedge meadows occur on sites that are similar to those that support shrub swamps, but they are wetter. Large meadows may fill shallow, poorly drained depressions that receive input from mineral-enriched groundwater, or they may form a narrow zone on stream or lake margins where they may be bordered by open water or marsh on the downslope side and shrub swamp on the upslope side. Sedge meadows are favorable habitats for assemblages of native plants and animals that are relatively scarce in other habitats.

“Southern Sedge Meadow,” dominated by tussock sedge (*Carex stricta*), does occur in northern Wisconsin, though it is not nearly as common as “Northern Sedge Meadow” (see Chapter 7, “Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin,” for descriptions of each natural community and aquatic feature type referenced in this document). Drained impoundments, including beaver flowages, may go through a stage where the dominant plants are species such as tussock sedge or bulrushes such as black bulrush (*Scirpus atrovirens*) or wool-grass (*S. cyperinus*). Such sites often succeed rapidly to shrub swamp or lowland forest, especially if there was an appreciable gradient to the dammed stream. Deliberate or inadvertent conversion of sedge meadow to marsh has been a common practice in the past, either inadvertently during dam construction or deliberately to improve habitat for game species, such as waterfowl, that benefit from the presence of open water. Although these activities may benefit certain species, the loss of habitat for other, typically less common, animal and plant species is a concern, and the long-term impacts of continuing such practices indefinitely need to be better evaluated.

Marshes are widespread in the North Central Forest Ecological Landscape but are more common in areas to the south with more fertile waters and warmer climates. Emergent, submergent, and floating-leaved marshes are present in the protected bays of many lakes, in some of the region’s low gradient streams and also in some impoundments. Wild rice marshes are more common here than in any other ecological landscape and are prized for their importance to wildlife as well as for their cultural values.

Dams have raised water levels and inundated marsh communities at some sites, altered or eliminated some other wetland habitats, and have sometimes created new marsh habitats elsewhere (i.e., in areas farther upstream). Shoreline development can damage or destroy wetlands and will continue to be an important conservation issue here because northern lakes are viewed as such desirable places to live.



Wood turtles are associated with moderate to fast-flowing streams but spend a large portion of the year out of the water in a variety of habitats ranging from wetlands to well-drained uplands. They have been known to travel long distances from the streams in which they overwinter. Photo by Drew Feldkirchner, Wisconsin DNR.

Invasive plants such as purple loosestrife, reed canary grass, Eurasian water milfoil, and curly pondweed are problems in parts of this ecological landscape.

Acid peatlands are widespread, locally common, and arguably the most characteristic wetland communities throughout the North Central Forest Ecological Landscape. Open and semi-open peatland communities include Open Bog, Poor Fen, and Muskeg. These differ structurally in their cover of shrubs (especially the bog shrubs in the family Ericaceae) and stunted bog conifers, but all of these are really dominated by a group of acidic “peat” mosses, mostly in the genus *Sphagnum*, which provide a continuous, though sometimes very hummocky, surface. Over long periods of time, the peat thickens, the communities are increasingly isolated from the influence of mineral-enriched groundwater and become more acidic, and tree stature and cover decrease (Crum 1988). Though overall diversity (richness) in these communities may be low, many of the plants and animals adapted to living in the harsh environments of the acid peatlands are highly specialized and occur in few other habitats.

Boreal Rich Fen is a rare in the North Central Forest as it is elsewhere in Wisconsin. This community also occurs on a carpet of peat-forming mosses, but genera other than the highly acidic *Sphagnum* are often the dominants. “Rich” fens are by definition somewhat alkaline, and these wetlands have the potential to support plants that are not only specialized but rare in Wisconsin. Hydrologic disruption is the greatest threat to all of the peatland communities.

Management Opportunities, Needs, and Actions

- Manage wetland communities as integrated vegetation complexes with shared hydrology. Encourage private landowners to maintain and protect, rather than eliminate, shrub-dominated wetlands.

- Protect or restore site hydrology.
- Avoid facilitating the introduction of highly invasive plants such as reed canary grass and glossy buckthorn into shrub swamps and sedge meadows via activities such as uncontrolled runoff or disturbance to wetland soils. Monitor high quality sites and treat infestations of problematic species as soon as possible.
- Cutting alder to “regenerate” it can lead to an increase of reed canary grass or other undesirable plants. If site conditions are favorable for the maintenance of alder, manipulation should not be necessary for it to persist. If the site is reverting (or succeeding) to forest, “regeneration” will become a chronic need.
- Sedge meadows, especially when large, support a distinctive assemblage of plants and animals. Some of the animals are area-sensitive, (e.g., Sandhill Crane [*Grus canadensis*], Northern Harrier, American Bittern), and others key in on sedge meadow structure (Sedge Wren [*Cistothorus platensis*], Le Conte’s Sparrow), or a combination of area and structure (Yellow Rail).
- The nonforested northern fens (especially “Boreal Rich Fen”) are relatively rare. The influence of alkaline groundwater creates habitat conditions favored by a number of rare or habitat-restricted plants. “Poor Fens” can resemble sedge meadows and may appear to be sedge-dominated, but they support a continuous or nearly continuous carpet of sphagnum mosses.
- More detailed floristic surveys of shrub swamps, sedge meadows, fens, and marshes are desirable across most of northern Wisconsin, including the North Central Forest Ecological Landscape. Additional survey work is also needed to locate populations of rare plants and animals and assess the status of those species and the habitats that support them.
- Careful analysis is needed of the environmental and economic costs of any additional impoundments proposed for northern streams. Any contemplated conversion of sedge meadow, shrub swamp, or lowland forest to marsh should be accompanied by a thorough understanding of region-wide impacts to sedge meadows and other wetland communities and the many species dependent upon them.
- Maintain natural cycles of fluctuating water levels when possible. Ensure that water quantity remains adequate at all times of the year to maintain sensitive aquatic life, and avoid negative impacts to water quality due to increased sediment or pollutant loads.
- Attach “sensitive area” designations to sites that meet the criteria as one means of protecting wetlands from degradation caused by human activity. Lakes with existing or pending development should receive critical habitat surveys and the information gathered adopted in lake management or land use management plans.



Floating open peatlands and conifer swamp surrounding a kettle pond with abundant aquatic macrophytes, Iron County. Photo By Drew Feldkirchner, Wisconsin DNR.

- Undeveloped lakes, especially “large lakes” of over 50 acres, are becoming increasingly rare where they have not already received a measure of formal protection. Remaining examples should receive critical habitat surveys, have baseline data collected on physical and chemical characteristics, and be examined for the presence of high quality or rare wetland communities, rare species populations, and use by migratory birds.
- Monitor for and control the spread of “new” invasive species outbreaks. Develop priorities for implementing control measures of existing populations of invasives.
- Shoreline and shallow water habitat protection is essential to maintaining viable beds of emergent macrophytes, including wild rice populations. To protect aquatic vegetation adopt no-wake zones, buffer shorelines, manage uplands to prevent erosion and sedimentation, limit input of pollutants, and restore damaged shorelines.
- Continue the current system of tribal and state rice bed restoration and maintenance (GLIFWC 2003).

Forested Watersheds and Headwaters of Important Rivers and Lakes

Many lakes, rivers, streams, and other waterbodies in the North Central Forest are in good condition compared to waterbodies elsewhere in the state. Water quality is high, sediment and pollutant loads are low, flow levels tend to follow normal patterns on many streams, and the diversity of aquatic organisms is significant for both common (“representative”) and sensitive species. In large part this may be attributed to the high percentage of forest cover throughout the ecological landscape that has protected the waterbodies from the negative impacts (e.g., eutrophication, loss of undeveloped shoreline and key wetland habitats, disturbance to sensitive habitats

and species) that are more severe and widespread elsewhere in the state. The headwaters or other important stretches of important river systems, including the Wisconsin, Chippewa, Flambeau, Black, Pine, Popple, Oconto, and Wolf, are embedded within the extensive forests of the North Central Forest.

Currently in Wisconsin, water quality provisions are routinely included as part of land management practices using best management practices (BMPs) for water quality (WDNR 2010a). A set of timber sales is routinely chosen for monitoring to evaluate the success of the BMP program. It will be important to continue monitoring and adapt tools as needed to continue to protect water quality over time.

A small number of lakes here and elsewhere around the state have been designated by the Wisconsin DNR as state natural areas to protect valuable habitats and rare and representative species populations and also to serve as “benchmarks” against which the impacts of various types of land

use, development, and management can be compared. In cases where the state natural area comprises only the waterbody itself, it will be important to provide sufficient buffers against degradation and follow forestry BMPs for water quality if these lakes are to be maintained in excellent condition (WDNR 2010a).

Water, fish, and invertebrate sampling show that a large portion of lakes in the North Central Forest have been identified (in Wisconsin DNR basin plans) as having very good water quality and habitat values, including some very large lakes, such as Grindstone, Lac Court Oreilles, Big Round, Sand, Stone, and Whitefish, and many smaller lakes. Numerous developed lakes have been recommended as candidates for implementing critical habitat surveys to determine if they qualify as “Sensitive Areas” that limit disturbance by watercraft and other activities to protect critical aquatic habitat. These lakes should be surveyed as staffing levels allow, and habitat protection plans based on the survey findings should then be developed.

Where residential or industrial developments are concentrated or where impoundments have been constructed, conditions have often deteriorated for coldwater aquatic organisms because of increased water temperatures, higher sediment loads, loss of shoreline cover, increase in impermeable surfaces in the local watershed, and introduction of invasive species. Basin plans for the North Central Forest Ecological Landscape point out that there are many opportunities to work cooperatively with owners of riparian areas to restore damaged shoreline habitats.

Management Opportunities, Needs, and Actions

- Maintaining the existing high percentage of forest cover within watersheds is arguably the most critical and cost-effective factor in maintaining high water quality and supporting all of the aquatic species native to Wisconsin's lakes and streams. Continuing or implementing forest management practices that maintain a high percentage of forest cover is critical to prevent damaging increases in water temperature and sediment loads. Manage for a minimum of 40–60% of forest cover in each local watershed, depending on a complex of factors, including soil type, slope, aspect, and the need to protect spring recharge areas.
- Protecting rivers, along with their floodplains, corridors, and including associated lowlands and adjacent uplands, is the most ecologically effective strategy to achieve long-term protection of water quality and shoreline habitats. This will increase the amount of habitat available, allowing for the movement of species upslope and downslope as environmental conditions change over time, and provide migratory bird stopover habitat. It should also provide suitable habitat for species that require large areas and/or a mosaic of interconnected habitats, including a full range of seral stages, for their long-term survival.
- Monitor waterbody use by sensitive species and expand surveys for poorly known aquatic taxa. Protecting and



Undeveloped lake with intact hydrology and forested watershed. Flambeau River State Forest, Price County. Photo by Eric Epstein, Wisconsin DNR.



Undisturbed headwaters complex, consisting of creek, sedge meadow, shrub swamp, and black spruce swamp, with managed hemlock-hardwood-pine forest in the distance. Wildcat Creek, Northern Highland State Forest. Vilas County. Photo by Eric Epstein, Wisconsin DNR.

restoring natural lake and stream habitat, including establishing refuge areas and appropriately managing aquatic plants, are needed for conservation of species that require clear waters and littoral zone vegetation, such as the pugnose shiner.

- Incorporate lakes, rivers, and streams into management and protection plans for terrestrial resources wherever feasible and appropriate, including management plans for federal, state, and county properties. Protect spring ponds, including the potentially fragile natural vegetation around them, from damaging uses; document dredging on features in addition to game fish; and protect sensitive sites from dredge spoil disposal, trampling, road or other right-of-way construction, grading, and filling. Buffer uplands and manage shorelines to prevent erosion and sedimentation and limit pollutant inputs.
- Restore wild rice where appropriate (e.g., to areas it had formerly occupied) once the reasons for its decline or disappearance are known.
- Wisconsin DNR staff should encourage local communities to implement Smart Growth planning by demonstrating its multiple environmental and economic benefits and continue to work with lake associations, local governments, angler groups, and other affected and interested citizens to recommend ways to maintain or restore high quality habitat and excellent water quality. Recommendations include protecting or restoring natural shoreline vegetation and littoral zones, the adoption of no-wake zones to protect sensitive vegetation or other important habitat features, and deterrence of recreational activities that destroy or degrade habitat or lower water quality.
- Manage dams and impoundments to protect sensitive species (e.g., wintering amphibians or reptiles, nesting loons, terns, and waterfowl). Avoid managing water levels outside of the natural range of variability, which would reduce community diversity over time. Some progress has been made through the Federal Energy Regulatory Commission (FERC) relicensing process in modifying the operation of the many hydropower dams in this ecological landscape, especially to help reduce fish mortality. However, opportunities exist to make more improvements in the future.
- Provide fish passages around dams (e.g., on the Flambeau, Yellow, and Chippewa rivers) or remove dams to benefit isolated populations of aquatic organisms and aid their dispersal. Among the many species that would potentially benefit from this are the Wisconsin Endangered bullhead mussel and the Wisconsin Special Concern lake sturgeon. Continue to implement elements of the Flambeau River system sturgeon recovery plans, including the operational adjustments at the Rest Lake Dam on the Manitowish River and monitoring of the Manitowish River and Turtle-Flambeau Flowage sturgeon populations.

- Protecting and maintaining spring flow is essential to maintaining coldwater habitats and the associated assemblage of native invertebrates and fish. Maintaining a high percentage of forest cover, leaving spring recharge areas and outlets undisturbed, and limiting groundwater withdrawals within the spring recharge area are essential to keeping streams cold and clean.

Ephemeral Ponds

Ephemeral ponds, also known as “vernal pools,” are natural depressions, usually in forested landscapes underlain by materials of relatively low permeability (e.g., fine-textured soils such as silts or clays). These depressions are typically small (<1 to about 10 acres) and hold water for several weeks to several months following spring snowmelt. They may remain partially filled during abnormally wet years or refill periodically after heavy rains. Colburn (2004) provides an excellent primer on vernal pool ecology.

The North Central Forest is currently Wisconsin’s most important location for these ecologically significant features, which are key breeding habitats for invertebrates and amphibians, support foraging birds and mammals, and may provide habitat for unusual assemblages of vascular and nonvascular plants. The North Central Forest has the highest abundance of ephemeral ponds in Wisconsin and the best opportunities to protect them within an intact forested landscape.

Some ephemeral ponds have been destroyed or damaged in the past, either inadvertently or deliberately. Damage can be a result of filling, hydrologic modifications, or logging operations that drop treetops and brush into the pond’s basin or isolate the pond (e.g., via road construction) from important upland habitats. The adjacent uplands may serve as sources of runoff, recharge, or summer habitat for amphibians and other species that use these ponds at other times over the course of a year.



Ephemeral (or “vernal”) ponds are common features on rolling ground moraines where fine-textured soils may impede drainage. Such ponds provide critical habitat for amphibians and other organisms. Flambeau River State Forest, Sawyer County. Photo by Eric Epstein, Wisconsin DNR.

Management Opportunities, Needs, and Actions

- Ephemeral ponds are small and fragile features, and management of surrounding lands needs to be sensitive to the environment of the pond, the areas around the pond, and the species that use them. Protection of site hydrology and the pond's immediate watershed are the primary management considerations.
- Ephemeral ponds had not been well studied in Wisconsin, but several projects to identify, map, and assess these unique waterbodies are in progress (C. Hardin, Wisconsin DNR, personal communication).
- There is a need for comprehensive surveys to better understand the abundance, distribution, composition, structure, and function of ephemeral ponds. Use the process developed for the Wisconsin Ephemeral Ponds Project to establish the probable locations of potential ephemeral ponds (PEPs). As staffing and volunteer field help allow, conduct field surveys to verify, map, and characterize PEPs and the wildlife and plants they support, including identifying potential land use threats to the integrity of each site.
- Ephemeral ponds need more recognition among land managers and conservationists as ecologically fragile and important features.
- See *Wisconsin's Forestry Best Management Practices for Water Quality* (WDNR 2010a) for best management practices that now include some considerations for ephemeral ponds. There is a need for the development of detailed management guidelines for ephemeral ponds, on both public and private lands, wherever timber harvests or development activities are occurring.
- Provide management guidelines and incentives for restoring and maintaining effective forested buffers. Use information derived from recent ephemeral pond studies to establish guidance for the size and configuration of forested buffers for ephemeral pond protection. Additional information regarding this community type in northern Wisconsin would be useful, including the development of management recommendations.

Bedrock Features

Most of the North Central Forest Ecological Landscape is buried under glacial deposits, making bedrock features uncommon and highly localized, yet bedrock exposures do play significant and unique ecological roles here. The Penokee Range forms the northwestern boundary of this ecological landscape. Among the significant ecological features of the Penokees are extensive unbroken tracts of mesic hardwood and hemlock-hardwood forest, deep conifer-clad, rock-walled gorges, waterfalls, and high-gradient softwater streams. Exposures of bedrock are represented by cliffs, talus slopes, and glades (also referred to by some as “balds”), all of which are capable of supporting highly specialized plants and animals.

Winter weather systems coming across Lake Superior can deliver high amounts of snow to the Penokee-Gogebic Iron Range, driving white-tailed deer to lower elevations. This may be an important factor in the recovery of browse sensitive plants such as eastern hemlock and Canada yew. Mild winters in recent years have brought at least some of this recovery to an abrupt halt, reversing some of the apparent gains made by these species in recent years. Based on weather data from Gurney (in northern Iron County at the edge of the Penokee-Gogebic Iron Range), that area “historically” received twice as much snow as it does at present (J. Meeker, Northland College, personal communication). At Gurney, both northern white-cedar and eastern hemlock were showing recruitment through about 1960, but at sites below the 1,100 feet elevation level, no northern white-cedar had regenerated since 1910. Eastern hemlock fared relatively poorly at the lower elevation sites, but “did all right” at Gurney, even after 1960. It is surmised that white-tailed deer reached another population plateau around 1980 (perhaps in part due to the reduced snowfall), and now eastern hemlock is also suffering reproduction failure at Gurney. Other



High-gradient stream, cliffs, and boreal conifers. Penokee-Gogebic Range, Iron County. Photo by Eric Epstein, Wisconsin DNR.

significant exposures of bedrock occur in the Blue Hills of Barron and Rusk counties, along the Gile Flowage in Iron County, and in the eastern part of the Nicolet National Forest (e.g., McCaslin Mountain and along the Brule River in Florence County).

The rugged nature of some exposed bedrock features can protect plant species, especially where slopes are exceedingly steep or where deep gorges have created accessibility issues. Commercial logging operations, road building, motorized recreation, and dense residential developments often avoid these areas for safety and economic reasons. Plants highly susceptible to browse damage, such as eastern hemlock, Canada yew, and showy mountain ash (*Sorbus decora*), may persist in locations that are beyond the reach of browsing ungulates such as white-tailed deer. Such habitats can serve as refugia for sensitive plants in landscapes where they have been reduced in abundance or even eliminated. Streams that originate from such areas tend to have cold, clear water that is also very soft. Sensitive invertebrates and several rare plant species occur in or on the banks of such streams.



This felsenmeer ("sea of rocks") is composed of quartzite talus in the Blue Hills of Barron-Rusk counties. Rare vascular plants and lichens occur here. Photo by Eric Epstein, Wisconsin DNR.

Submerged, or partially submerged, rocky habitats such as river rapids and river "dalles" may also create suitable habitat for sensitive aquatic animals (good examples occur along the South Fork of the Flambeau River within the Flambeau River State Forest). Exposed rock on streambanks and lakeshores provides habitat for specialized plants and animals. Such habitats are also used as feeding areas by many animals. Abandoned mines in the Penokee-Gogebic Iron Range provide important habitat for bats,² as do some older forests that have retained a complement of large living and dead cavity trees.

Management Opportunities, Needs, and Actions

- Work with public land managers to identify and protect sites with significant bedrock features.
- Avoid or terminate land uses that cause erosion or that otherwise disturb or damage sensitive habitats. Moss and lichen communities can be exceedingly slow to recover from disturbance.
- Develop interpretive sites on bedrock areas that are not sensitive to access.
- Survey poorly known taxa such as nonvascular plants and certain invertebrate groups to improve knowledge of bedrock habitats and provide better guidance for stewards.
- More systematic surveys of bedrock environments are needed throughout the state to document and clarify the geographic and substrate variability of these highly specialized habitats, refine habitat classifications, and interpret the information to establish conservation priorities and enable better conservation decisions.
- Rivers and streams with bottom materials of bedrock, boulders, cobbles, or gravel often have high value to sensitive aquatic organisms and merit strong protection.
- Assess the importance of abandoned mines in the Penokee Range to bats.

Glacial Features

Glacial landforms are well represented here and include end and ground moraines, kettles and *kettle lakes*, pitted outwash, drumlins, eskers, ice-walled lake plains, outwash channels, and outwash plains. Each is associated with a mosaic of characteristic vegetation, aquatic features, species assemblages, and conservation opportunities. Nearly all of the area

²On 6/1/2011, four bats were added to the Wisconsin threatened species list: big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and eastern pipistrelle (*Perimyotis subflavus*). This was an emergency listing due to the rapid spread of the often fatal disease known as white-nose syndrome. The four Wisconsin "cave" bats are especially vulnerable because they may travel great distances and spend time together in confined spaces, hibernating over the winter in caves and mines where they can become infected with the fungus that causes white-nose. Some hibernacula have experienced mortality rates greater than 98%.



End moraine is a glacial feature characterized by rough topography, areas of poor internal drainage, and numerous ponds and wetlands. This example features a complex mosaic of natural communities, undeveloped lakes and ponds, and other aquatic features. Chippewa County. Photo by Eric Epstein, Wisconsin DNR.

is underlain by glacial till that impedes drainage, giving rise to numerous lakes and wetlands. Extensive forested drumlin fields occur here, some of them with wetlands between the drumlins, but many of these have been modified by road building and forest management such that ecotones between wetlands and uplands have often been disrupted. Eskers have been extensively mined for gravel, and few intact examples remain. Many ice-walled lake plains have been cultivated or repeatedly logged, and shoreline development has occurred on many kettle lakes.

Management Opportunities, Needs, and Actions

- Identify and protect existing undeveloped eskers from mining and housing development. Work with public land managers to highlight their scarcity and educational value.
- Develop interpretations for glacial features in conjunction with existing recreational developments (e.g., nature trails) where possible. Additional interpretations may be desirable on public lands in locations that are not sensitive to access.
- Forested drumlin fields with undisturbed ecotones connecting to wetlands are scarce. There are some opportunities to protect existing examples and possibly to restore some areas with disturbed ecotones.
- Encourage and support the completion of geologic mapping in the ecological landscape.
- Promote understanding of the influence of glacial history and landforms on management issues such as site moisture and nutrient holding capacity, the occurrence of certain types of lakes and wetlands, and the sensitivity and suitability of sites to management.

Socioeconomic Characteristics

Socioeconomic information is summarized within county boundaries that approximate ecological landscapes unless specifically noted as being based on other factors. Economic data are available only on a political unit basis, generally with counties as the smallest unit. Demographic data are presented on a county approximation basis as well since they are often closely associated with economic data. The multi-county area used for the approximation of the North Central Forest Ecological Landscape is called the North Central Forest counties. The counties included are Bayfield, Washburn, Rusk, Sawyer, Chippewa, Iron, Ashland, Price, Taylor, Lincoln, Langlade, Forest, and Florence because at least 25% of each county lies within the ecological landscape boundary (Figure 12.17).

History of Human Settlement and Resource Use

American Indian Settlement

The archaeology of northern Wisconsin is fragmentary and often poorly understood. There are many gaps in our understanding of the cultural evolution of early peoples in northern Wisconsin. It can be generally said that technology and traditions occurred earlier in southern Wisconsin than in northern Wisconsin. See Chapter 2, "Assessment of Current Conditions," for a description of the cultural traditions of Wisconsin.

Although sporadic, there is evidence of habitation in the North Central Forest as far back as the Late Paleo-Indian Phase (7,000 to 8,000 years ago) at the Doering site in Price County and at the Robinson site in Oneida County (Mason 1997). There is little archaeological evidence of great significance in the North Central Forest Ecological Landscape during the time of the Archaic Tradition but enough to say that this ecological landscape was occupied during this time.



Figure 12.17. North Central Forest counties.

There is more evidence of occupation by the time of the Woodland Tradition, with a Middle Woodland house basin as well as Late Woodland cemetery, burials, and mounds found at the Robinson site in Oneida County, and other Late Woodland evidence found in several places including at the Zarling Lake and Treaty Tree sites in Forest County (Stevenson et al. 1997).

At the time of Euro-American contact, the Santee Dakota likely claimed much of what is now the North Central Forest Ecological Landscape. The Ojibwe tribe, or “puckered moccasin people,” migrated south from what is now Michigan’s Upper Peninsula along rivers near the end of the 17th century (The Wisconsin Cartographer’s Guild 1998). In doing so, they gradually displaced the Santee Dakota people, who then moved further west and eventually out of Wisconsin.

The Ojibwe moved according to a seasonal subsistence economy. Most of the region occupied by the Ojibwe today is underlain by the Canadian Shield, granitic bedrock, overlain by glacial till with thin, often relatively infertile soils, and hardwood or mixed forests. Climate, soils, and cultural traditions made the practice of agriculture quite difficult (The Wisconsin Cartographer’s Guild 1998). The tribe engaged in fishing in the summer; wild rice harvesting in the fall; hunting, trapping, and ice fishing in the winter; and tapping maple syrup and spear fishing in the spring. Their main building material was birch bark, which provided both canoes and shelter, since the bark could be transported anywhere.

Euro-American Contact and Settlement

French fur traders, missionaries, and soldiers began arriving in the region during the mid-17th century. These early Europeans made contact with the American Indians and subsequently set up trading posts, missions, and forts along lakes and rivers used as travel routes. By 1820 hunting and trapping in northern Wisconsin had depleted the wildlife resource, and the fur trade moved farther north into Canada. Soon after, American Indian tribes began ceding their lands to white settlers (see Chapter 2, “Assessment of Current Conditions,” for information about the *Ceded Territory*).

There are five American Indian reservations that lie at least partly within the North Central Forest Ecological Landscape, all bands of the Ojibwe except the Potawatomi. The Lac Courte Oreilles, Mole Lake (Sokaogon), and Forest

County Potawatomi reservations lie entirely or mostly within this ecological landscape. The Bad River and Lac du Flambeau reservations have only small portions within this ecological landscape.

Early Agriculture

Permanent Euro-American settlement began in earnest in the North Central Forest counties around 1850. In 1850 U.S. census estimates placed populations of just 489 people in Bayfield County and 615 in Chippewa County (ICPSR 2007). In 1850 there were reportedly only five farms in North Central Forest counties, all in Bayfield County, though a handful of farms must have been established in Chippewa County by that time. Chippewa County has consistently had the largest agricultural base of all North Central Forest counties. Not until after 1880 did Euro-American population or permanent farm settlements begin to take hold in many North Central Forest counties. In 1880 only six of the 13 North Central Forest counties had any farms at all, totaling 2,131 farms. Mirroring the delayed agricultural development in the North Central Forest counties, Rusk County was not even founded until 1901 (NACO 2010).

As the Cutover reached even the most northerly and isolated North Central Forest counties by the end of the 19th century, farm settlements increased on cut-over land that generally turned out to be poorly suited for agriculture. In 1900 North Central Forest counties had an estimated 8,961 farms (Figure 12.18) and a total population of 137,118 (ICPSR 2007). By

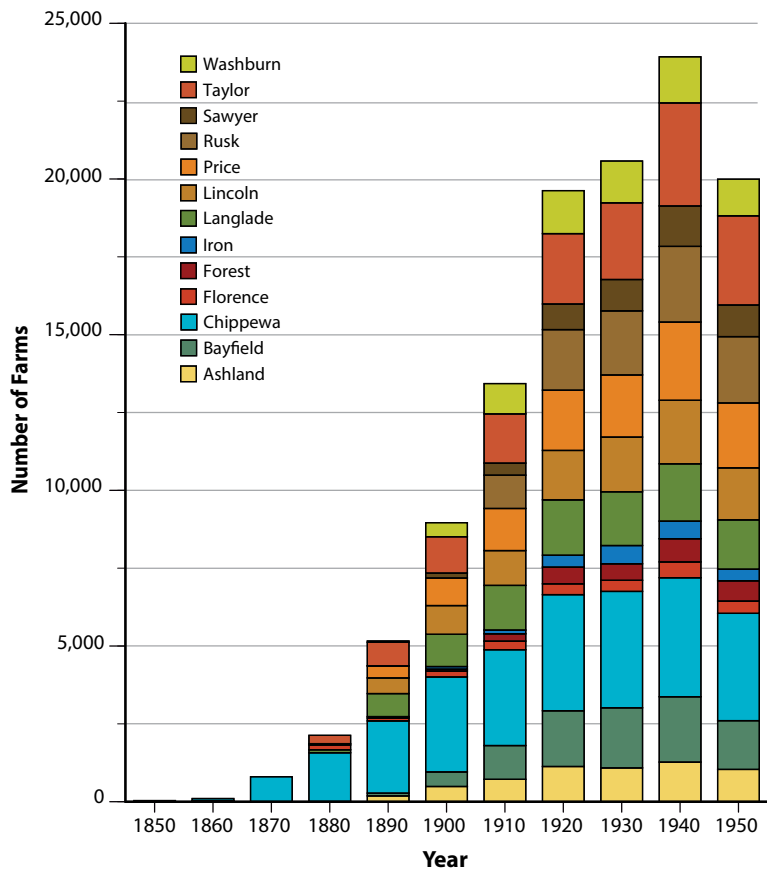


Figure 12.18. Number of farms in North Central Forest counties, 1860–1950 (ICPSR 2007). (Note that many of the agricultural lands in Chippewa and Taylor counties are outside of the North Central Forest Ecological Landscape and may bias the results of this figure.)

1920 the number of North Central Forest farms had more than doubled to 19,626. Increase in farm numbers in North Central Forest counties slowed dramatically in the 1930s following the onset of the Great Depression. However, farm numbers had swelled again by 1940 to 23,924 in North Central Forest counties. Euro-American populations in North Central Forest counties continued to grow throughout the decades but fell behind statewide population growth in more urban areas after 1920. During and following World War II, North Central Forest counties' farm numbers began to decline sharply because much of the marginal land proved ill-suited for intensive agriculture (ICPSR 2007). Mechanization also contributed to an increase in the average size of farms (Figure 12.19). That trend continued throughout much of the remaining 20th century. Farms tended to be slightly smaller on average in North Central Forest counties than in the state as a whole, until North Central Forest counties' farm size surpassed the state average in about 1950, averaging 145 acres in comparison to 138 acres statewide (Figure 12.19).

Total value of all crops indicates the extreme influence of the Great Depression on agriculture. In 1910 all crops harvested in North Central Forest counties had an estimated total value of \$9 million, which quadrupled by 1920 (\$36.1 million) (ICPSR 2007). However, total value of all crops in North Central Forest counties plummeted in 1930 (\$19.1 million) and fell further in 1940 (\$12.8 million). Total values of crops in North Central Forest counties comprised only 7.6% of total crop value in the state in 1940 even though these crops came from farms comprising 12.5% of all Wisconsin farm acreage. Farms in North Central Forest counties historically have not been as productive as the state as a whole, in part due to less fertile soils and shorter growing seasons than counties to the south.

Over the early part of the 20th century, North Central Forest counties' farms became increasingly concentrated in production of hay and forage at an even greater proportion than seen statewide. The 1910 federal agricultural census listed "cereals" as only 29.4% of the total value of all crops harvested in North Central Forest counties, compared to 49.3% of statewide crop value (ICPSR 2007). By 1940 cereals comprised only 20.5% of crop value in North Central Forest counties, following a similar trend of decline statewide. Meanwhile, "hay and forage," associated with livestock farming, was 33.3% of total value of crops harvested in North Central Forest

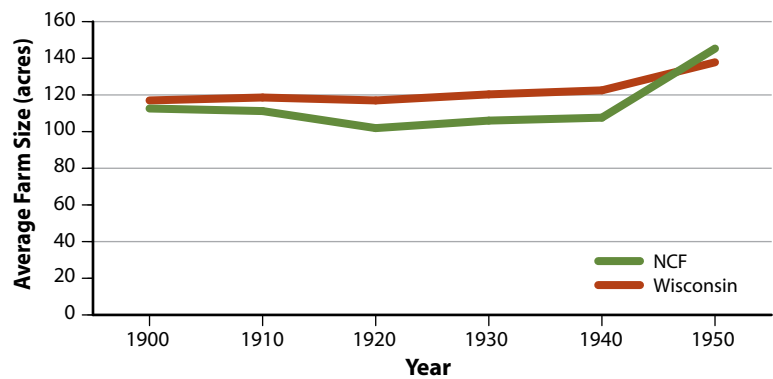


Figure 12.19. Average farm size in North Central Forest counties between 1900 and 1950 (ICPSR 2007).

counties in 1910, compared to only 27.5% statewide. By 1940 hay and forage had risen to 57% of total crop value in North Central Forest counties. In Iron (74.8%), Ashland (72%), Price (71.8%) and Taylor (71%) counties, hay and forage was an especially high proportion of their total crop value by 1940. See the "Statewide Socioeconomic Assessments" in Chapter 2, "Assessment of Current Conditions," for further discussion of the history of agricultural settlement in northern Wisconsin.

Early Mining

In 1826 the Lake Superior band of Ojibwe granted the federal government the right to search for and remove metals or minerals on tribal land. The Penokee-Gogebic Iron Range is located in the northern part of the North Central Forest Ecological Landscape, partially in Michigan and in Wisconsin where the Montreal River divides the two states. Iron ore was reported in the area in 1848. The subsequent opening of various mines attracted a new wave of settlers in the 1880s.

Iron and zinc were important to the mining history of Wisconsin, but the state also contained all or parts of six separate iron ranges. Iron mining began in the mid-1800s and continued through the early 1980s. The Florence County mines on the Menominee Range in the North Central Forest produced roughly 7 million tons of iron ore by 1955 (The Wisconsin Cartographer's Guild 1998).

Early Transportation and Access

Early American Indian residents and Euro-American settlers traveled through the North Central Forest region by navigating the extensive network of lakes and rivers. Villages, camps, and trading posts were built near water bodies and trail confluences. In 1829 an extensive network of American Indian trails existed throughout the territory. These trails were widened into roads suitable for ox carts and wagons due to the rapid settlement growth during the 1830s (Davis 1947). A system of military roads was developed in Wisconsin around the same time, connecting key cities and forts with one another. By 1870, however, the importance of railroads had caused highways to become of secondary importance.

While the North Central Forest Ecological Landscape has never had any major cities, several major railroad lines have operated in this region of the state, including the Chicago and North Western, which connected Superior with Chippewa Falls, and the Soo Line, which connected the Superior area with Spencer in Marathon County (Fisher 1937). Additional companies had a substantial amount of track in this region of the

state as well. The Glidden and Northeast Railroad, Roddis Lumber and Veneer Company, and the J.R. Davis Lumber Company all operated within Ashland County. Further, the Sawyer-Goodman Lumber Company, Tipler Grossman Lumber Company, Von Platen-Fox Lumber Company, and Menominee Bay Shore Lumber Company all operated within Florence County during the late 1800s and early 1900s. See the “Statewide Socioeconomic Assessments” in Chapter 2, “Assessment of Current Conditions,” for further discussion of the history of transportation in Wisconsin.

Early Logging Era

The logging industry became established in the ecological landscape in the latter half of the 19th century. Extensive fires often followed logging. The fires burned the slash and debris left from logging operations but also burned young trees and saplings that might have replaced trees in the cut-over lands. Eastern white pine was the original tree of choice, and after its depletion, loggers turned to eastern hemlock and hardwoods. Access to trees and delivery to sawmills was expedited by the network of waterways that was used to float logs to the mills. Scouring of river bottoms and deposition of bark and other woody debris changed the character of many rivers. Subsequent transportation of logs to mills was facilitated by the establishment of railroads. “Tannery towns” existed between 1870 and 1900 and harvested 100,000 cords of bark (and only bark) from eastern hemlock annually for the tannery industry. Piles of bark and some eastern hemlock logs can still be found in the woods in Ashland County from this time period. The timber industry attracted settlers and helped support other economic activities in the North Central Forest counties such as agriculture, mining, housing construction, and railroad building, which in turn helped support the timber industry.

Roth (1898) described forest conditions in some of the northern Wisconsin counties at the end of the 19th century (Rusk County was not part of Roth’s survey). In Ashland County, pine was reported to have been heavily harvested in the mixed forest of the southern portion of the county and in the north along Lake Superior (associated with the Superior Coastal Plain Ecological Landscape). Pine remained predominant within the Bad River Indian Reservation and along streams but was estimated at only 300 million **board feet**, compared to relatively uncut stands of eastern hemlock and hardwoods; pine was cut while eastern hemlock and hardwoods were generally not harvested at this time. Northern white-cedar, tamarack, and black spruce stocked Ashland County’s forested lowlands. Yield per acre was estimated at 4,000 board feet for both eastern hemlock and hardwoods where those stands predominated in the southern portion of Ashland County, associated with the North Central Forest Ecological Landscape. Eastern hemlock volume was estimated at 700 million board feet. Yellow birch, American basswood, and maple were the principle species among the estimated 900 million board feet of hardwoods, comprising 60% of that volume, while oak was considered a secondary

species (Roth 1898). By comparison, today there are an estimated 201 million board feet of pine, 114 million board feet of eastern hemlock, and over 1 billion board feet of hardwood **sawtimber** in all of Ashland County forests (USFS 2009).

In Bayfield County, Roth (1898) noted that pine had been harvested heavily along Lake Superior, along the Namekagon and White rivers in the southeastern third of the county, and along the Northern Pacific Railway (all in the Superior Coastal Plain Ecological Landscape). Vast acreages of land were barren in the wake of the Cutover. However, a vast pine resource of an estimated 3 billion board feet remained uncut at the time of Roth’s report. The belt associated with the Northwest Sands Ecological Landscape was comprised largely of jack and red pine, with eastern white pine of more sporadic occurrence. Northern white-cedar, tamarack, and to a lesser extent black spruce were dominant in the numerous wetlands in the southeastern portion of Bayfield County. Standing volume of eastern hemlock was estimated at 400 million board feet. White birch, American basswood, and maple were the principle merchantable hardwood species, which also totaled an estimated 400 million board feet. By comparison, today there are an estimated more than 1 billion board feet of pine, 96 million board feet of eastern hemlock, and over 1.5 billion board feet of hardwood sawtimber in Bayfield County forests (USFS 2009). However, most of the pine is in the Northwest Sands Ecological Landscape sections of these counties.

In Chippewa County, the pine had largely been cut, especially along streams, leaving isolated patches comprising an estimated 500 million board feet (Roth 1898). The extensive swamps in the northeast were fire-damaged and poorly stocked. Fire damage in the wake of the pine Cutover had also damaged both hardwood and eastern hemlock stands. Eastern hemlock had not been heavily harvested, and its volume was an estimated 800 million board feet, with yield of 5,000 board feet an acre that exceeded hardwood yields. Heavy American basswood and yellow birch volumes in the northeast, associated with the North Central Forest Ecological Landscape, represented more than half of all hardwood volume. By comparison, today there are 155 million board feet of pine and only 25 million board feet of eastern hemlock in Chippewa County. However, eastern hemlock reaches its range limits in northeastern Chippewa County and is generally not found in any abundance in the North Central Forest Ecological Landscape portion of the county. There is about 557 million board feet of hardwood sawtimber in Chippewa County forests today (USFS 2009).

Florence County was once a mixed forest of pine, hardwoods, and eastern hemlock but was heavily affected by fire, with burns covering 20% of the land area. The pine had been largely cut, leaving an estimated 150 million board feet standing (Roth 1898). Eastern hemlock and hardwood stands had only been harvested in small patches near established towns. Eastern hemlock had a standing volume of around 300 million board feet, while hardwoods were an estimated 400 million

board feet. American basswood, yellow birch, and maples were the principle hardwood species, comprising three-quarters of all hardwoods. Oak species were scarce. Florence County's swamps were relatively well stocked at an estimated 100 million board feet. By comparison, today there are 206 million board feet of pine, 173 million board feet of eastern hemlock, and 623 million board feet of hardwood sawtimber in all of Florence County (USFS 2009).

Roth (1898) reported that most of Forest County's pine had been cut, though an estimated 500 million board feet remained standing. The cut-over pine slash areas were mostly burned bare. Hardwoods and eastern hemlock stands were largely uncut and unscathed by fire, however. Eastern hemlock stands totaled an estimated 500 million board feet. Hardwoods were dominated by white birch and American basswood and had an estimated 1 billion board feet still standing. Forest County had some open bogs, but the majority of swamps were stocked with a total of 300 million board feet of northern white-cedar, tamarack, and black spruce. By comparison, today there are 195 million board feet of pine, 166 million board feet of eastern hemlock (although there is a 30% sampling error), and 1.7 billion board feet of hardwood sawtimber in Forest County forests (USFS 2009).

In Iron County, pine had been harvested in parts of each township, with heavy removals in some areas (Roth 1898). Locally, parts of southern Iron County had a lot of pine, while the remainder of the county was mixtures of hardwoods, pine, and eastern hemlock. Roth (1898) noted that eastern hemlock and hardwoods had been cleared from areas around the mines. Other than that, these species were relatively uncut and had not extensively succumbed to fire. Swamps were plentiful, especially in the southern portion of the county, and contained northern white-cedar, tamarack, and black spruce. Roth (1898) estimated that in the late 1800s, Iron County forests contained 400 million board feet of pine and 350 million board feet each of eastern hemlock and hardwoods. Noted hardwoods were white birch, American basswood, and maple. By comparison, today there are 129 million board feet of pine, 144 million board feet of eastern hemlock, and 717 million board feet of hardwood sawtimber in Iron County forests (USFS 2009).

Roth (1898) described extensive mixed hemlock-hardwood forests in Langlade County, interspersed with patches and belts of pine. The pine, however, had been largely cut, and totaled

only 150 million board feet of standing timber. Largely untouched by harvests or fire, the Langlade County hardwood forests remained well stocked, with an estimated 1 billion board feet of eastern hemlock and 1.1 billion board feet of hardwoods. In equal parts, white birch, American basswood, and elm were about 80% of all hardwoods, while maple and ash species comprised a smaller hardwood component. By comparison, today there are 107 million board feet of pine, 41 million board feet of eastern hemlock, and nearly 1.1 billion board feet of hardwood sawtimber in Langlade County forests (USFS 2009).

Roth (1898) described 80% of Lincoln County covered by mixed sand and clay soils supporting mixed pine, eastern hemlock, and hardwood forests. Pine was the principle cover type on the sandier soils. Pine had largely been cut, leaving an estimated 250 million board feet standing. Largely untouched by harvests or fire, the Lincoln County hardwood forests remained well stocked, with an estimated 1 billion board feet of



Log jam on the Wisconsin River. Wisconsin DNR photo.



Logging near Rice Lake, Wisconsin. A group of men use a team of four horses to transport logs across snow-covered ground on a sled. Photograph courtesy of the Wisconsin Historical Society, Image ID WHI-78303.

each eastern hemlock and hardwoods. White birch, American basswood, and elm were the principle hardwood species, comprising about 70% of all standing hardwood volume. Dominated by northern white-cedar and tamarack, many of the swamps were either harvested or damaged by fires spilling over from cut-over pine lands. According to Roth (1898), these cut-over areas totaled thousands of acres of bare terrain unsuitable for agriculture. By comparison, today there are 312 million board feet of pine, 25 million board feet of eastern hemlock, and 577 million board feet of hardwood sawtimber in Lincoln County forests (USFS 2009).

Roth (1898) described Price County as greatly affected by the Cutover, which removed its formerly impressive pinery. Remaining standing volume of pine was estimated at only 200 million board feet scattered throughout the county, especially in the northern two-thirds of the county where it once was part of a “most luxuriant mixed forest” (Roth 1898). Mixed hardwood and eastern hemlock stands in over half of Price County were reportedly fire-damaged, with large areas of forest burned by fires. In spite of especially severe fire damage, Price County still contained an estimated 1 billion board feet of eastern hemlock and 900 million board feet of hardwoods on nearly 400,000 acres of forested land. The hardwood forests were dominated by white birch and American basswood, followed by elm and maple. By comparison, today there are 156 million board feet of pine, 112 million board feet of eastern hemlock, and 832 million board feet of hardwood sawtimber in Price County forests (USFS 2009).

Sawyer County was largely unsettled and had not yet been heavily affected by the Cutover at the time of Roth’s survey. Pine had only been heavily harvested along the principal rivers, and estimates of the standing pine volume ranged from an impressive 2 billion to 2.5 billion board feet (Roth 1898). Eastern hemlock, present only in the northern two-thirds of the county, totaled an estimated 900 million board feet. Hardwood stands had an estimated volume of 1 billion board feet and were dominated by white birch and American basswood. Oak comprised about 10% of all hardwoods and was especially prevalent in the western portion of Sawyer County. Swamp lands were estimated to cover 12% of Sawyer County but were extensively damaged by fires when in the vicinity of cut-over pine areas. By comparison, today there are 687 million board feet of pine, only 65 million board feet of eastern hemlock, and more than 1.8 billion board feet of hardwood sawtimber in Sawyer County forests (USFS 2009).

Taylor County was once covered by a continuous mixed forest, but at the time of Roth’s survey, the pine had been largely cut, leaving small patches in the southwest totaling an estimated 200 million board feet (Roth 1898). Nonetheless, 60% of Taylor County’s wild lands remained under forest cover, and it was relatively unscathed by forest fire. Eastern hemlock remained a prevalent species in the remaining forests, with estimates of stand volume ranging from 1.5 to 2 billion board feet. Roth (1898) estimated hardwood volumes (predominantly American basswood and white birch) at 1 billion board

feet. Swamps in Taylor County were stocked with tamarack especially, along with northern white-cedar and black spruce. By comparison, today there are 134 million board feet of pine, 105 million board feet of eastern hemlock, and 767 million board feet of hardwood sawtimber in Taylor County forests (USFS 2009).

Washburn County was largely covered in pine prior to the Cutover (especially the sandy areas in the Northwest Sands Ecological Landscape), but only 350 million board feet of pine remained at the time of Roth’s survey. According to Roth’s observations, “some of the largest areas of perfectly bare cut and burned-over lands in Wisconsin occur in this (Washburn) County” (Roth 1898). In the wake of the heavy pine Cutover, Washburn County hardwoods suffered heavily from forest fires. Only 220 million board feet of hardwoods were estimated, with large areas bare of merchantable timber. Together, nearly equal parts American basswood, maple, oak and white birch made up 80% of all hardwood volume (Roth 1898). By comparison, today there are 265 million board feet of pine and 683 million board feet of hardwood sawtimber in Washburn County forests (USFS 2009).

Resource Characterization and Use³

The North Central Forest is the second largest of Wisconsin’s ecological landscapes with 9,212 square miles of land and 331 square miles of surface water. The population density of 19 people per square mile is the lowest in the state.

In the North Central Forest Ecological Landscape, almost 42% (2.6 million acres) of all land and water is publicly owned. The North Central Forest Ecological Landscape is 31% more densely forested than the state as a whole (see the map “Public Land Ownership, Easements, and Private Land Enrolled in Forest Tax Programs in the North Central Forest” in Appendix 12.K at the end of this chapter). The density of trails is higher than average as is the number of hunting and fishing licenses sold. This ecological landscape has the highest number of Land Legacy sites, many of which have significant recreation potential.

Agriculture is not a major factor in the economy of the North Central Forest Ecological Landscape. Forestry, on the other hand, is much more important to the economy. Among Wisconsin’s ecological landscapes, the North Central Forest Ecological Landscape has the second highest percentage of its land in forest and the highest overall acreage as well as the highest *growing stock* volume and removals.

Along with a very low population density, the North Central Forest Ecological Landscape has a very low density of roads, railroads, and airport runways, ranking 15th (out of 16) in this measure. There are only four airports and no ports.

³When statistics are based on geophysical boundaries (using GIS mapping), the name of the ecological landscape is followed by the term “ecological landscape.” When statistics are based on county delineation, the name of the ecological landscape is followed by the term “counties.”

Although the North Central Forest Ecological Landscape does not use much energy for its low population, it is a major producer of hydroelectric power and a potentially large producer of woody biomass. With 22.3% of all woody biomass in Wisconsin, its forests are the largest potential producers of biomass of all ecological landscapes. This ecological landscape county approximation is the second largest generator of hydroelectric power and has the largest number of hydroelectric power dams in the state. There are no wind or ethanol plants in this ecological landscape.

The Land

Of the 5.9 million acres of land that make up the North Central Forest Ecological Landscape, 82% is forested, according to Forest Inventory and Analysis (FIA) data (USFS 2009). About 54% of all forested land is privately owned while 23% belongs to the state, counties, or municipalities, and 23% is federally owned.

Minerals

The North Central Forest Ecological Landscape holds nearly all of Wisconsin's remaining major, economically significant metallic ore deposits. (For detailed information, see WDNR 2014). It is the location of the now closed and reclaimed Flambeau Mine, an open pit copper-gold sulfide ore mine that operated for a little over four years (1993–1997). Less concentrated ore remains below the existing 225-foot deep pit adjacent to the Flambeau River near Ladysmith. Other mines in this ecological landscape include a dozen underground iron ore mines that operated southwest of Hurley from the 1880s through 1965.

Other known, undeveloped metallic ore bodies here are the Lynne, Crandon, and Bend deposits. The Lynne Deposit in southwest Oneida County features zinc sulfide, with significant lead and silver and minor amounts of gold and copper. Mining companies are considering further exploration regarding a potential open pit mine on county forestland.



Flambeau Mine, 1997. Photo by Wisconsin DNR staff.

The Crandon Deposit in Forest County has an estimated 55 million tons of sulfide ore containing zinc, copper, lead, gold, and silver in a band nearly a mile long and almost half a mile deep. A proposed underground mine project underwent permit review beginning in the early 1980s, but in 1986 the applicant withdrew the permit application after the completion of a final environmental impact statement. Another company submitted a mine permit application in 1995 but in 2003 withdrew the application, and the Ojibwe and Potawatomie tribes purchased the mineral rights to the Crandon Deposit.

Nineteen miles north northwest of Medford lies the Bend Deposit, in the Chequamegon-Nicolet National Forest. The Bend Deposit is a large zinc sulfide ore body with significant lead and silver and small amounts of gold and copper. Exploratory drilling resumed here in 2012 for a potential underground mine.

The Penokee-Gogebic Iron Range, trending 21 miles southwest from Hurley into Iron and Ashland counties, contains the Penokee/Gogebic Taconite Deposit. The deposit contains up to 30% iron in the form of magnetite and hematite of a much lower grade than ore mined in the Hurley area through 1965. This lower-grade ore must be concentrated and processed into taconite pellets prior to shipping to a steel mill.

Flambeau Mining Company (a subsidiary of Kennecott Minerals Company) mined copper and gold ore from an open pit adjacent to the extremely biologically diverse Flambeau River from 1993 to 1997 then reclaimed the site by backfilling the pit with limestone and waste rock and flooding the filled pit to minimize acid formation. Flambeau Mining Company completed a Wisconsin DNR-approved mine reclamation plan in 1999. Monitoring generally continues to show that the reclaimed mine meets applicable water quality and other standards, but Flambeau Mining Company will be responsible for maintaining the site in perpetuity.

In 2012 there were 12 mining establishments in the North Central Forest counties (USCB 2012a). With five mining establishments involved in the production of nonmetallic minerals, only Chippewa County has full disclosure of mining revenues. Due to limited participation in mining, employment and earnings information is not disclosed for the other North Central Forest counties.

Water (Ground and Surface)

Water Supply

The data in this section are based on Wisconsin DNR's 24K Hydrography Geodatabase (WDNR 2012a), which are the same as the data reported in the "Hydrology" section of this chapter; however, the data are categorized differently here so the numbers differ slightly. Surface water covers 212,000 acres in the North Central Forest Ecological Landscape, or 3.5% of the total area. There are over 5,517 lakes that are at least 1 acre in size totaling more than 188,000 acres, or 89% of total surface water. There are 57 lakes over 500 acres and 26 that are over 1,000 acres in size. There are over 22,000 acres of streams and rivers and almost 112,000 acres of impounded water.

Water Use

Each day 186 million gallons of ground and surface water are withdrawn in the 13 North Central Forest counties (Table 12.4). About 57% of the withdrawals are from surface water. Of the 244,020 people that reside in these counties, 46% are served by public water sources and 54% are served by *private wells* (USGS 2010). This again reflects the nonurban nature of this ecological landscape. Ashland County accounts for 31% of all water withdrawals, mostly for thermoelectric once-through power generation. Langlade and Sawyer counties account for another 32% of withdrawals with most of this for irrigation and other agricultural purposes. The largest water usage, 30%, is for thermoelectric power generation.

Recreation

Recreation Resources

Land use and ownership patterns partly determine the type of recreation that is available to the public. For instance, in the North Central Forest Ecological Landscape, there is far less agricultural land and 31% more forested land compared to the rest of the state (see Chapter 3, “Comparison of Ecological Landscapes,” in Part 1 of this book and/or the map “WISCLAND Land Cover (1992) of the North Central Forest” in Appendix 12.K at the end of this chapter). There is more public land in general, especially under federal ownership. The density of trails is higher than average as is the number of hunting and fishing licenses sold (Wisconsin DNR unpublished data). This ecological landscape has the highest number of Land Legacy sites, many of which have significant recreation potential.

Supply

■ **Land and Waters.** The North Central Forest Ecological Landscape accounts for 17% of Wisconsin’s total land area (second

largest in the state) and 16.6% of the state’s acreage in water, also second highest (see Chapter 3, “Comparison of Ecological Landscapes”). There are 4.8 million acres of forestland in the North Central Forest Ecological Landscape, 29.4% of the total acreage in the state (based on FIA data; USFS 2007). Streams and rivers make up 10% of the surface water area of the North Central Forest Ecological Landscape and lakes, and reservoirs account for over 89% (WDNR 2012a). The largest rivers are the Flambeau, Chippewa, and the Wolf rivers, and the largest lakes are Chippewa Lake, Lac Courte Oreilles, Pelican Lake, Round Lake, and Grindstone Lake.

■ **Public Lands.** Public access to recreational lands is vital to all types of recreational activity. In the North Central Forest Ecological Landscape, almost 2.6 million acres, or 42% of the area in land and water, is publicly owned (WDNR 2005a), significantly higher than the statewide average of 19.5%, and ranks this ecological landscape fourth (out of 16 ecological landscapes) in the proportion of public ownership. There are about 211,800 acres of public waters, 219,800 acres of state recreational lands, 1.2 million acres of federally owned land, and 940,000 acres of county forests and natural areas.

State-owned lands and facilities are important to recreation in the North Central Forest Ecological Landscape. There are over 106,000 acres of state forest, including the Flambeau River State Forest and part of the Northern Highland State Forest, and over 7,000 acres in state parks and recreation areas, including Copper Falls and Brunet Island state parks (WDNR 2005a). In addition, there are 99,024 acres of state natural areas (both totally and partially state owned), 3,200 acres of state trails, including the Nicolet, Tuscobia, and Ice Age trails, and 24,330 acres of wild rivers, including the Chippewa and Turtle-Flambeau flowages. Fisheries and

Table 12.4. Water use (millions of gallons/day) in the North Central Forest counties.

County	Ground-water	Surface water	Public supply	Domestic ^a	Agriculture ^b	Irrigation	Industrial	Mining	Thermoelectric	Total
Ashland	0.8	54.3	1.0	0.3	0.7	0.1	2.5	0.0	51.0	55.2
Bayfield	6.0	7.9	0.4	0.5	11.7	0.2	0.2	0.9	–	13.8
Chippewa	11.6	4.3	5.7	0.6	1.8	3.3	4.0	0.6	–	16.0
Florence	0.3	0.0	0.1	0.0	0.0	0.2	–	0.1	–	0.4
Forest	1.1	0.7	0.3	0.2	1.1	0.2	–	0.1	–	1.8
Iron	0.6	0.5	0.4	0.1	0.0	0.5	–	0.0	–	1.0
Langlade	20.6	14.2	1.2	0.5	17.1	15.3	0.2	0.5	–	34.8
Lincoln	2.9	9.6	1.3	0.8	0.3	0.5	8.1	0.1	1.0	12.5
Price	3.1	9.9	1.3	0.5	0.3	0.5	6.8	0.0	4.0	13.0
Rusk	2.0	1.9	0.6	0.4	0.6	0.7	1.4	0.3	–	3.9
Sawyer	25.1	0.6	7.7	1.4	1.9	12.7	1.5	0.4	–	25.7
Taylor	2.6	0.7	0.6	0.6	0.9	0.2	0.0	0.9	–	3.3
Washburn	3.4	1.2	0.8	0.6	1.4	1.7	0.1	0.0	–	4.6
Total	80.1	105.8	21.4	6.5	37.8	36.1	24.8	3.9	56.0	186.0
% of total	43%	57%	11%	3%	20%	19%	13%	2%	30%	

Source: Based on 2005 data from the U.S. Geological Survey on water uses in Wisconsin counties (USGS 2010).

^aDomestic self-supply wells.

^bIncludes aquaculture and water for livestock.

wildlife management lands cover over 70,300 acres. The largest of these, Hay Creek-Hoffman Lake State Wildlife Area, the Upper Wolf River Fishery Area, the Kimberly-Clark State Wildlife Area, and the Pershing State Wildlife Area, each provide over 5,000 acres of recreational land.

■ **Campgrounds.** There are 266 public and privately owned campgrounds that provide about 8,367 campsites in the North Central Forest counties (Wisconsin DNR unpublished data). With 15% of the state's campgrounds, this ecological landscape has the highest number of campgrounds but ranks ninth in terms of campground density (campgrounds per square mile of land).

■ **Trails.** The North Central Forest counties have over 7,600 miles of recreational trails (Table 12.5) and rank seventh (out of 16 ecological landscapes) in trail density (miles of trail per square mile of land) in the state (Wisconsin DNR unpublished data). There is a higher density of ATV, cross-country ski, and snowmobile trails but a lower density of hiking and biking trails compared to the rest of the state.

■ **Land Legacy Sites.** The Land Legacy project has identified over 300 places of significant ecological and recreational importance in Wisconsin, and 41 are either partially or entirely located within the North Central Forest Ecological Landscape (WDNR 2006c). Five of them are rated as having high recreation potential: the Chequamegon-Nicolet National Forest, the Chippewa Flowage, the Chippewa Glacial Lakes, the Flambeau River State Forest, and the Turtle-Flambeau Flowage. Seven are rated as having high conservation significance: the Border Lakes Region, the Chequamegon-Nicolet National Forest, the Moose Creek Hemlock Woods, the Penokee-Gogebic Iron Range, the upper Chippewa River, the Upper Forks of the Flambeau River, and the upper Wolf River.

■ **State Natural Areas.** The North Central Forest Ecological Landscape also contains 99,024 acres of state natural areas (partially or totally located within the ecological landscape), of which 97% is publicly owned (including government and educational institutions), and 3% is owned by joint public-private interests (including NGOs) (Wisconsin DNR unpublished data). The largest state natural areas in this ecological

landscape include St. Peter's Dome (5,102 acres, Ashland County), Moose Lake (4,294 acres, Iron County), Atkins Lake and Hiles Swamp (3,462 acres, Forest and Oneida counties), Spring Brook Drumlins (3,162 acres, Ashland, Price, and Sawyer counties), and Mondeaux Hardwoods (2,826 acres, Taylor County). For more information regarding Wisconsin state natural areas, see Wisconsin DNR (2013c).

Demand

■ **Visitors to State Lands.** In 2004 there were an estimated 306,807 visitors to state parks and forests in the North Central Forest Ecological Landscape (Wisconsin DNR unpublished data). About half visited the Brunet Island State Park, and half visited the Flambeau River State Forest.

■ **Fishing and Hunting License Sales.** Of all license sales, the highest revenue producers for the North Central Forest counties were resident hunting licenses (36% of total sales), nonresident fishing licenses (27% of total sales), and resident fishing licenses (23% of total sales). Table 12.6 shows a breakdown of various licenses sold in the North Central Forest counties in 2007. The highest number of licenses were sold in Chippewa County, but Sawyer County accounted for the highest revenue from sales. The North Central Forest counties accounted for about 9% of total license sales in the state. However, persons buying licenses in the North Central Forest counties may travel to other parts of the state to use them.

■ **Metropolitan Versus Nonmetropolitan Recreation Counties.** A research study (Johnson and Beale 2002) classified Wisconsin counties according to their dominant characteristics. One classification is "nonmetro recreation county." This type of county is characterized by high levels of tourism, recreation, entertainment, and seasonal housing. Seven of the North Central Forest counties are classified as nonmetro recreation counties: Bayfield, Florence, Forest, Iron, Price, Sawyer, and Washburn counties. This is the highest number in any of the ecological landscape county approximations.

Recreational Issues

Results of a statewide survey of Wisconsin residents indicated that a number of current issues are affecting outdoor recreation opportunities within Wisconsin (WDNR 2006b). Many

Table 12.5. Miles of trails and trail density in the North Central Forest counties compared to the whole state.

Trail type	North Central Forest counties (miles)	North Central Forest counties (miles/100 mi ²)	Wisconsin (miles/100 mi ²)
Hiking	91	0.7	2.8
Road biking	209	1.6	4.8
Mountain biking	186	1.5	1.9
ATV: summer & winter	2,133	16.8	9.3
Cross-country skiing	976	7.7	7.2
Snowmobile	4,049	31.9	31.2

Source: Wisconsin DNR unpublished data.

Table 12.6. *Fishing and hunting licenses and stamps sold in the North Central Forest counties.*

County	Resident fishing	Nonresident fishing	Miscellaneous fishing	Resident hunting	Nonresident hunting	Stamps	Total
Chippewa	18,565	3,955	498	25,099	391	4,608	53,116
Langlade	11,584	1,911	238	14,830	268	5,215	34,046
Lincoln	10,846	3,709	284	14,024	310	3,564	32,737
Taylor	5,338	572	173	11,055	207	1,758	19,103
Washburn	7,900	11,729	171	9,485	773	2,630	32,688
Ashland	3,969	1,174	517	9,140	446	4,615	19,861
Bayfield	5,421	6,206	960	5,854	592	5,274	24,307
Florence	2,209	1,084	64	4,147	333	996	8,833
Forest	4,829	1,010	45	6,134	154	1,625	13,797
Iron	2,721	3,642	105	4,284	432	1,751	12,935
Price	6,123	3,355	353	9,688	882	2,101	22,502
Rusk	4,181	1,141	310	8,218	395	1,511	15,756
Sawyer	10,199	23,500	265	8,688	861	2,869	46,382
Total	93,885	62,988	3,983	130,646	6,044	38,517	336,063
Sales (\$)	\$2,154,163	\$2,522,978	\$74,055	\$3,370,452	\$817,113	\$336,102	\$9,274,863

Source: Wisconsin DNR unpublished data, 2007.

of these issues, such as increasing ATV usage, overcrowding, increasing multiple-use recreation conflicts, loss of public access to lands and waters, invasive species, and poor water quality, are common across many regions of the state.

■ **Silent Sports Versus Motorized Sports.** Over the next decade, the most dominant recreation management issues will likely revolve around conflicts between motorized and nonmotorized recreation interests. From a silent-sport perspective, noise pollution from motorized users is one of the higher causes for recreation conflict (WDNR 2006b). Recreational motorized vehicles include snowmobiles, ATVs, motor boats, and jet skis. ATV use is especially contentious. ATV riding has been one of the fastest growing outdoor recreational activities in Wisconsin. Many ATV riders feel there is a distinct lack of ATV trails and are looking primarily to public lands for places to expand their riding opportunities.

■ **Loss of Access to Lands and Waters.** With the ever-increasing development along shoreline properties and continued parcelization of forestlands, there has been a loss of readily available access to lands and waters within the North Central Forest Ecological Landscape. This may come from the fact that housing developments have become more concentrated with the advent of condominium developments on shorelines that have closed large areas of lakeshore once open to the casual recreation user. Another element that may also play into the perception of lost access is the lack of information about where to go. This element was ranked high on a list of barriers for increased outdoor recreation in a statewide survey (WDNR 2006b).

■ **Timber Harvesting.** A high percentage of statewide residents are concerned about timber harvesting in areas where they recreate. Their greatest concern about timber harvesting is



The shorelines and nearshore waters of many lakes and streams across Wisconsin are now characterized by residential and recreational developments. The aquatic vegetation, adjacent wetlands, and upland forests that provided important habitat for native plants and animals have often been replaced by homes, condominiums, piers, sandblankets, lawns, and associated infrastructure such as roads, driveways, and power line rights-of-way. Photo by Wisconsin DNR staff.

large-scale visual changes (i.e., large openings) in the forest landscape. Forest thinning and harvesting that creates small openings is more acceptable. Silent-sport enthusiasts as a group are the most concerned about the visual impacts of harvesting, while hunters and motorized users are somewhat less concerned.

Agriculture

Farm numbers in the North Central Forest counties have decreased 37% since 1970. There were approximately 10,650 farms in 1970 and 6,747 farms in 2002 (USDA NASS 2004).

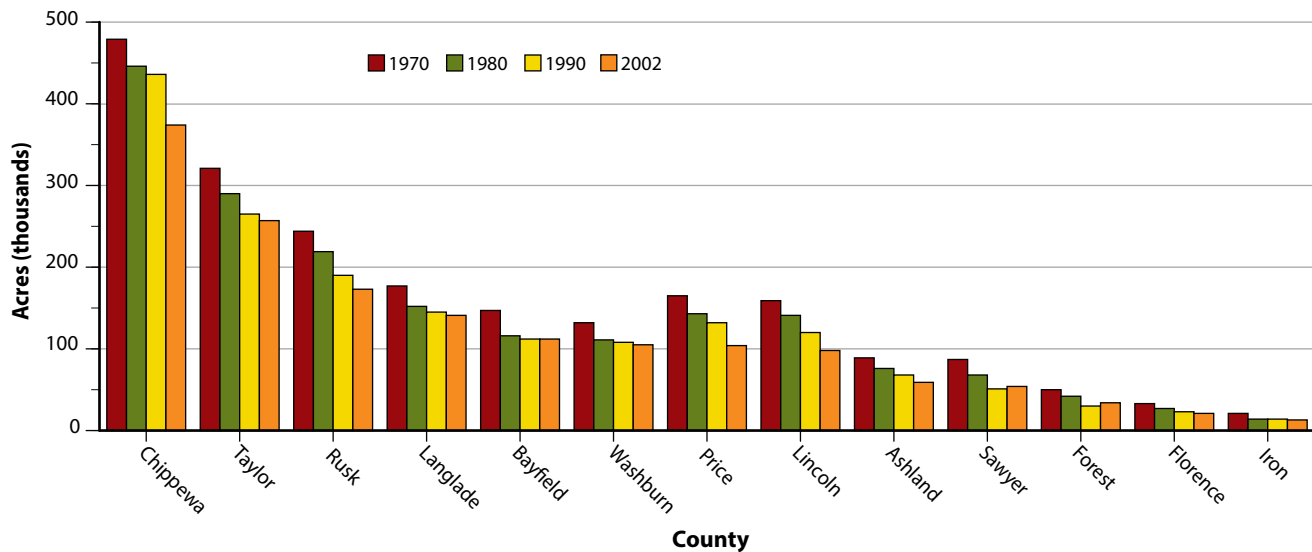


Figure 12.20. Acres of farmland by county and year in the North Central Forest counties (USDA NASS 2004).

Between 1970 and 2002, average farm size increased from 203 acres to 222 acres, which is higher than the statewide average of 201 acres. The overall land in farms has steadily decreased since the 1970s (Figure 12.20). In 1970 there were about 2.1 million acres of farmland, and by 2002 acreage was down to 1.5 million acres, a decrease of 27%. For the 13 counties of the North Central Forest, the percentage of land in farms ranges from 2% to 56%, averaging 18%. The counties with the highest percentage of agricultural land are Chippewa County with 56% and Taylor County with 41%. However, most of the agricultural land in these two counties is not in the North Central Forest Ecological Landscape. Much of the marginal farmland in Wisconsin is reverting to forest or grassland as new landowners use the land for purposes other than agriculture.

Agriculture is not an important part of the economy of most of the North Central Forest counties. In 2002, net cash farm income totaled \$96 million, or an average of \$62 per agricultural acre, much lower than the statewide average of \$91 per acre (USDA NASS 2004). The market value of all agriculture products sold in the North Central Forest counties was \$340 million (4% of state total); 26% of this amount came from crop sales, while the remaining 74% was from livestock sales. Chippewa County is the only county in which agriculture is an important part of the economy (for areas outside of the North Central Forest Ecological Landscape). It ranks fairly high with respect to net cash income as well as dairy and corn production.

In 2007, 12,176 acres of farmland were sold, of which 87% stayed in agricultural use at an average selling price of \$1,900, and 13% was diverted to other uses at an average sale price of \$17,076 per acre (USDA NASS 2009). North Central Forest counties have some of the lowest priced agricultural land in the state.

Timber

Timber Supply

Based on U.S. Forest Service Forest Inventory and Analysis (FIA) data, 82% (4,821,568 acres) of the total land area for the North Central Forest Ecological Landscape is forested (USFS 2007). This is over 29% of Wisconsin's total forestland acreage (USFS 2009).

Timber Ownership. Of all timberland within the North Central Forest Ecological Landscape, 54% is owned by private landowners, 23% is owned by state and local governments, and 23% is federally owned (USFS 2009; see Figure 12.21). **Timberland** is defined as forestland capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization.

Growing Stock and Sawtimber Volume. There were approximately 6.1 billion cubic feet of growing stock volume in the

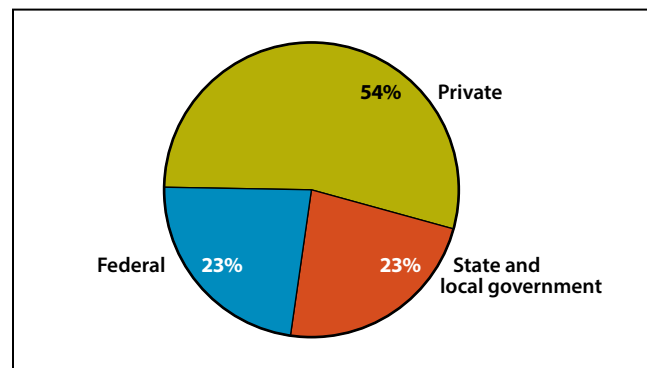


Figure 12.21. Timberland ownership in the North Central Forest counties (USFS 2009).

North Central Forest Ecological Landscape in 2007, or 30% of total volume in the state (USFS 2007). Most of this volume, 76%, was in hardwoods, similar to the proportion of hardwoods statewide which was 74% of total growing stock volume. Hardwoods made up a lower proportion, 67% of the sawtimber volume. In comparison, statewide sawtimber hardwood volume was also 67% of total volume.

■ **Annual Growing Stock and Sawtimber Growth.** Between 1996 and 2007, the timber resource of the North Central Forest Ecological Landscape increased by 107 million cubic feet, or just 2% (USFS 2007). Approximately 71% of this increase occurred in hardwood volume. Sawtimber volume increased by 1.6 billion board feet, or 11%. The larger percentage increase in sawtimber volume can be explained by a large ingrowth into the sawtimber size classes without equivalent replacement in the smaller size classes. So sawtimber became a larger percentage of total growing stock volume. Most of this change, 72%, occurred in hardwood volume. Timberland acreage remained essentially unchanged between 1996 and 2007 while, statewide, timberland acreage increased by 3% during the same time period.

■ **Timber Forest Types.** Forest types are combined into forest type groups based on Forest Inventory and Analysis (FIA); see Appendix H in Part 3, “Supporting Materials.” According to FIA data (USFS 2009), the predominant forest type groups in terms of acreage are maple-basswood (44%), aspen-birch (24%), and spruce-fir (14%), with smaller amounts of bottomland hardwoods, oak-hickory and white, red, and jack pines. Acreage is predominantly in the pole size class (42%) with smaller amounts in the sawtimber size class (34%) and in seedlings and saplings (24%) (see Table 12.7).

Timber Demand

■ **Removals from Growing Stock.** The North Central Forest Ecological Landscape has about 30% of the total growing stock volume of timberland in Wisconsin (USFS 2009). Average annual removals from growing stock for the ecological landscape were 91.5 million cubic feet, or 26% of total statewide removals (349 million cubic feet) between 2000–2002 and 2005–2007. (See the “Socioeconomic Characteristics” section in Chapter 3, “Comparison of Ecological Landscapes”). Average annual removals to growth ratios vary by species as can be seen in Figure 12.22 (only the major species are shown). Growth exceeds removals for most of the major species. However, removals significantly exceed growth for white birch, which is an aging pioneer species.

■ **Removals from Sawtimber.** The North Central Forest Ecological Landscape has about 27% of the total sawtimber volume on timberland in Wisconsin. Average annual removals from sawtimber were over 246 million board feet, or 23.4% of total statewide removals (1.1 billion board feet) between 2000–2002 and 2005–2007. Average annual removals to growth

ratios vary by species as can be seen in Figure 12.23 (only major species shown).

Price Trends

In the North Central Forest counties, black walnut, sugar maple, and northern red oak were the highest priced hardwood sawtimber species in 2007. Northern white-cedar, red pine, and eastern white pine were the most valuable softwood timber species. Sawtimber prices for 2007 were generally much higher for softwoods and higher for hardwoods compared to the rest of the state due to supply and demand factors (WDNR 2008a).

For pulpwood, sugar maple is the most valuable species at a rate of \$48 per cord. Pulpwood values in the North Central Forest counties were generally lower for hardwoods and much lower for softwoods compared to the statewide average (WDNR 2008a).

Infrastructure Transportation

The transportation infrastructure of the North Central Forest Ecological Landscape is much less developed than the rest of the state. For instance, road mile density is 35% lower (WDOA 2000), railroad density is 40% lower (WDOT 1998), and runway density is 69% lower than the state as a whole (WDOT 2012). There are eight airports in the North Central Forest Ecological Landscape, none of which are primary regional airports, and there are no shipping ports (WCPA 2010) (see Table 12.8).

Renewable Energy

Hydroelectric and wind turbine power are the only renewable energy sources quantified by county in Wisconsin energy statistics produced by the Wisconsin Department of Administration (WDOA 2006). Some general inferences can be drawn from other sources regarding the potential for renewable energy production in the counties of the North Central Forest Ecological Landscape. The North Central Forest has the potential to produce renewable energy from both hydroelectricity and woody biomass.

■ **Biomass.** Woody biomass is Wisconsin’s most used renewable energy resource. The North Central Forest counties produce 73 million cubic feet of logging residue annually, or 47% of total statewide production (USFS 2007). Approximately 82% of the land base is forested, and this decreased slightly in the last decade.

■ **Hydroelectric.** There are 11 hydroelectric dams that generate 287.6 million kilowatt hours (kWh) in the North Central Forest counties (WDOA 2006). In the entire state, there are 68 sites, owned either by utility companies or privately owned, that generate a total of 1,462 million kilowatt hours. The North Central Forest counties produce almost 20% of the hydroelectric power in the state.

Table 12.7. Acreage of timberland in the North Central Forest Ecological Landscape by forest type and stand size class.

Forest type ^a	Seedling/sapling	Pole-size	Sawtimber	Total
Sugar maple-beech-yellow birch	70,686	526,126	453,355	1,050,167
Aspen	470,749	450,629	118,936	1,040,314
Hard maple-basswood	23,899	281,554	444,770	750,223
Red maple – upland	17,367	156,859	59,802	234,029
Black ash-American elm-red maple	38,944	161,636	21,411	221,991
Black spruce	170,314	42,640	–	212,954
Tamarack	86,885	57,658	8,168	152,711
Northern white-cedar	4,308	35,861	97,521	137,691
Balsam fir	72,679	47,568	17,188	137,435
Northern red oak	638	16,111	114,869	131,618
White birch	16,240	71,119	19,364	106,723
Red pine	16,646	19,495	52,134	88,275
White oak-red oak-hickory	–	18,256	38,513	56,769
Red maple – lowland	25,406	14,420	2,354	42,180
Eastern hemlock	–	1,444	40,484	41,928
White pine-red oak-white ash	4,715	18,054	18,582	41,351
Eastern white pine	1,882	2,880	32,598	37,361
Nonstocked ^b	–	–	–	31,856
Other pine-hardwood	10,737	11,238	8,634	30,609
White spruce	3,870	8,986	17,443	30,298
Sycamore-pecan-American elm	10,913	10,619	–	21,532
Black cherry	17,026	3,769	661	21,455
Mixed upland hardwoods	9,372	5,260	2,960	17,591
Jack pine	14,023	–	–	14,023
Post oak-blackjack oak	7,919	–	6,007	13,926
Elm-ash-locust	8,533	3,460	–	11,993
White pine-hemlock	–	–	11,874	11,874
Cherry-ash-yellow-poplar	5,759	4,422	593	10,774
Sugarberry-hackberry-elm-green ash	2,328	4,236	2,762	9,326
Silver maple-American elm	–	1,561	5,951	7,512
Red maple-oak	–	5,848	–	5,848
River birch-sycamore	3,916	–	–	3,916
Willow	3,534	–	–	3,534
Chestnut oak-black oak-scarlet oak	–	–	2,878	2,878
Balsam poplar	–	–	2,872	2,872
White oak	–	602	983	1,586
Exotic softwoods and hardwoods	–	–	–	1,086
Total	1,119,288	1,982,313	1,603,667	4,738,210

Source: U.S. Forest Service Forest Inventory and Analysis (USFS 2009).

^aU.S. Forest Service Forest Inventory and Analysis (FIA) uses a national forest typing system to classify FIA forest types from plot and tree list samples. Because FIA is a national program, some of the national forest types in the above table do not exactly represent forest types that occur in Wisconsin. For example, neither post oak nor blackjack oak occur to any great extent in Wisconsin, but since there is no “black oak forest type” in the FIA system, black oak stands in Wisconsin were placed in the “post oak-blackjack oak” category.

^bNonstocked land is less than 16.7% stocked with trees and not categorized as to forest type or size class.

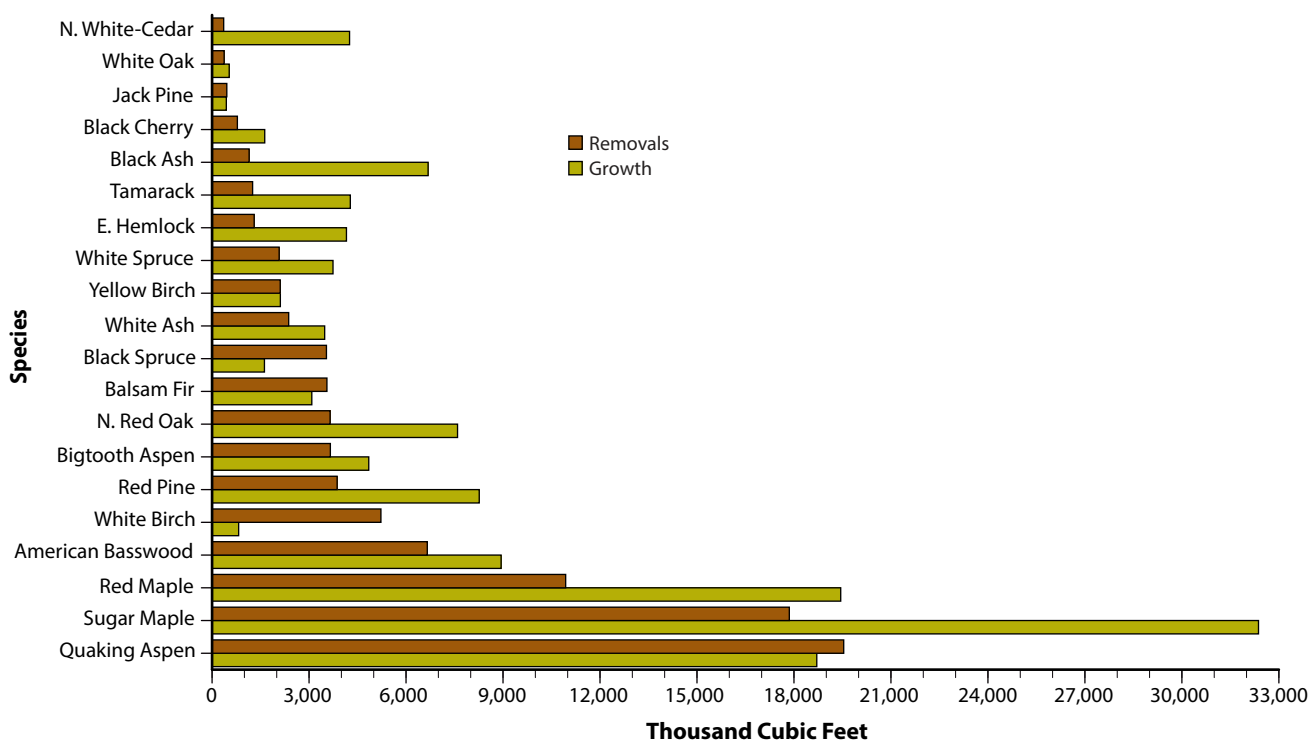


Figure 12.22. Growing stock growth and removals (selected species) on timberland in the North Central Forest Ecological Landscape (USFS 2009).

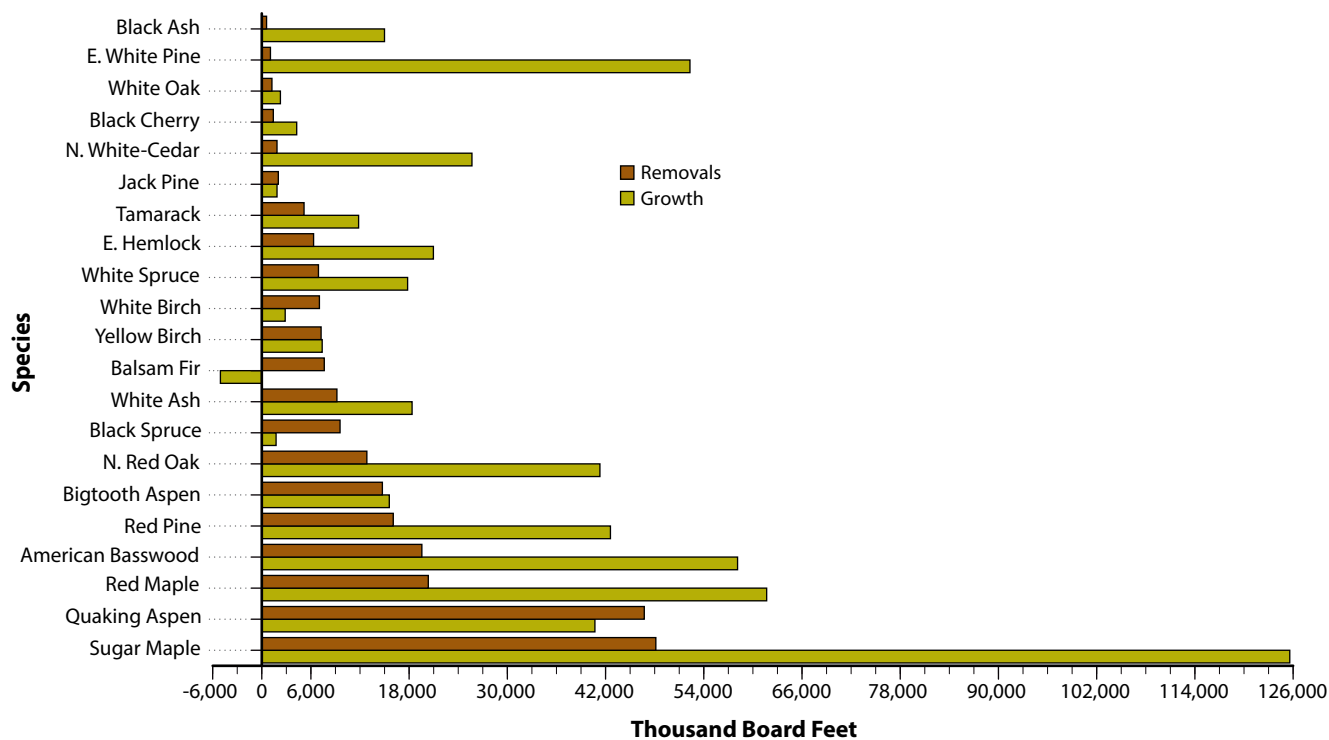


Figure 12.23. Sawtimber growth and removals (selected species) on timberland in the Central Sand Plains Ecological Landscape (USFS 2009).

Table 12.8. Road miles and density, railroad miles and density, number of airports, airport runway miles and density, and number of ports in the North Central Forest Ecological Landscape.

	North Central Forest	State total	% of state total
Total road length (miles) ^a	20,667	185,487	11%
Road density ^b	2.2	3.4	–
Miles of railroads	535	5,232	10%
Railroad density ^c	5.8	9.7	–
Airports	8	128	6%
Miles of runway	5.1	95.7	5%
Runway density ^d	0.5	1.8	–
Total land area (square miles)	9,212	54,087	17%
Number of ports ^e	0	14	0%

^aIncludes primary and secondary highways, roads, and urban streets.

^bMiles of road per square mile of land. Data from Wisconsin Roads 2000 TIGER line files (data set) (WDOA 2000).

^cMiles of railroad per 100 square miles of land. Data from 1:100,000-scale Rails Chain Database (WDOT 1998).

^dMiles of airport runway per 1,000 square miles of land. Data from Wisconsin Airport Directory 2011–2012 web page (WDOT 2012).

^eData from Wisconsin Commercial Ports Association (WCPA 2010).

■ **Ethanol.** The North Central Forest counties produced 16.4 million bushels of corn in 2002, or 2.8% of total production in Wisconsin (USDA NASS 2004). Acreage in agriculture made up only 18% of the land base (some woodland is counted as agriculture by this source), and this decreased by 27% between 1970 and 2002. There is limited potential for corn-based ethanol production here. There currently are no ethanol plants located in the North Central Forest counties (Renewable Fuels Association 2014).

■ **Wind.** Currently, there are no sited or proposed wind facilities in the North Central Forest Ecological Landscape (WWIC 2013). Mean annual power densities are generally below 100 W/m² (watts per square meter) in this part of the state indicating limited potential for wind power generation (USDE 2013).

Current Socioeconomic Conditions

North Central Forest counties are characteristically sparsely populated, with varied dependence upon tourism and manufacturing for the bulk of local economic output along with significant government employment. Most of the small urban centers in North Central Forest counties actually lie outside the geographic boundaries of the ecological landscape itself, but their economic influence defines much of the region nonetheless. The population of North Central Forest counties is largely white, aging, and lagging behind state population growth in most North Central Forest counties.

By all measures, but to varying degrees by county, earnings in the North Central Forest counties lag behind statewide averages. Though home values are very low, property values are elevated in some North Central Forest counties by higher recreational property values. While loss of a younger workforce and low wages are hindrances to the North Central Forest counties, the in-migration of retirees and prevalence of the tourism-related industry represent economic opportunities.

Demography

Population Distribution

According to the 2010 U.S. census, population for the 13 North Central Forest counties was 244,020, or 4.3% of the state total population (USCB 2012b). With the exception of Chippewa County, the North Central Forest counties are composed of nonmetropolitan (rural) counties as classified by the USDA Economic Research Service in 2004. Further, most urban centers (defined as cities with at least 2,500 inhabitants) in North Central Forest counties actually are outside of the physical boundaries of the ecological landscape. Of 10 urban centers in North Central Forest counties, only Ladysmith (population 3,285) in Rusk County lies geographically within the North Central Forest Ecological Landscape. For this reason, the demographic data that follows surely overstate the magnitude of the population in the North Central Forest Ecological Landscape. Officially, 71.5% of the population in North Central Forest counties lives in rural areas, though for the ecological landscape itself, we can assume the percentage of rural population to be even higher (USCB 2009).

Population Density

Even when including the cities that lie outside the ecological landscape boundaries, the 2010 population density of the North Central Forest counties is the lowest of any ecological landscape county approximation in Wisconsin. There are 19 persons per square mile in North Central Forest counties, compared to 105 persons per square mile in Wisconsin as a whole (USCB 2012b).

Population Structure

■ **Age.** The population in North Central Forest counties is older and aging compared to the rest of the state. According to the U.S. Census Bureau, approximately 21.9% of the 2010 population in North Central Forest counties was under

18 years old, compared to 23.6% statewide, while 18.1% of the population is 65 or older, compared to 13.7% statewide (USCB 2012b). Perhaps more telling is the low percentage of persons aged 25 to 49 (34%) in North Central Forest counties compared to the statewide average of 36.9%. This indicates a loss of young people and is an indicator of slowed growth and lowered birth rates. The median age in North Central Forest counties ranges from 37 years in Ashland County to 45 years in Iron County compared to the statewide average of 36 years (USCB 2009).

■ **Minorities.** The North Central Forest counties are less racially diverse than the state as a whole but comparable to other rural Wisconsin counties. Ninety-three percent of the 2010 population in North Central Forest counties is white and non-Hispanic, compared to 86.2% statewide. American Indian/Alaskan Native is the largest minority group of the North Central Forest counties' population, comprising 3.4% in 2010, followed by the Hispanic group (1.3%).

American Indian populations are particularly concentrated in Sawyer County (16.7% of total population), Forest County (13.5%), Ashland County (11.1%), and Bayfield County (9.6%) (USCB 2012b). The Lac Courte Oreilles Reservation is within the borders of Sawyer County, and the Forest County Potawatomi Reservation is within Forest County's borders. Although the Red Cliff Reservation is within Bayfield County's borders and the Bad River Reservation is within Ashland County, these reservations are located in portions of the counties outside of North Central Forest boundaries, in the Superior Coastal Plain, so these population figures are likely overstated.

■ **Education.** North Central Forest counties' residents 25 years of age or older have a lower educational attainment level than the statewide average. According to the 2010 Census, 87.9% of North Central Forest counties' residents 25 or older have graduated from high school, compared to 89.4% statewide (USCB 2012b). The discrepancy grows in terms of higher education; only 17.0% of North Central Forest counties' residents have received at least a bachelor's degree or higher, compared to 25.8% statewide. It is likely that youth leave the area to go to college and don't return—an educational out-migration.

Population Trends

North Central Forest counties are among the least populated in the state, and many are experiencing population loss. The percentage of the state population in the North Central Forest counties has dropped significantly since 1950, when it was 6.3% (USCB 2009). From 1950 to 2006, only 11 Wisconsin counties have experienced net population loss; five of the six greatest population losses occurred in North Central Forest counties. Sparsely populated Iron County alone lost 37% of its 1950 population by 2006, while Ashland (-16%), Rusk (-12%), Price (-10%), and Langlade (-8%) counties also experienced net loss over the period. While Wisconsin's overall

population grew by 62% from 1950 to 2006, North Central Forest counties' combined population grew only 14%, according to Census Bureau estimates. Much of that moderate growth occurred in the most populous North Central Forest counties of Chippewa County and Lincoln County, where urban centers actually lie outside the boundaries of the ecological landscape.

Housing

■ **Housing Density.** The North Central Forest counties have the second-lowest housing density (12.4 housing units per square mile of land) of any ecological landscape in the state for 2010 (USCB 2012c). Only Chippewa County (27.0 units per square mile) has even half of the statewide average housing density of 48.5 units per square mile. The remaining North Central Forest counties, ranging from Lincoln County's 19.1 units per square mile to Iron County's 7.9 units per square mile, include 8 of the 10 lowest housing densities in the state.

■ **Seasonal Homes.** Seasonal and recreational homes made up a quarter (25.3%) of housing stock in 2010 in the North Central Forest counties (USCB 2012d). Of North Central Forest counties, only Chippewa County (4.0%) has a lower percentage of seasonal homes than the statewide average of 6.3%. Seasonal and recreation homes comprise nearly half of all housing units in Sawyer (44.2%), Florence (51.0%), and Forest (47.5%) counties. Percentage of seasonal housing in the remaining North Central Forest counties ranges from Iron (42.8%) to Chippewa (4.0%).

■ **Housing Growth.** From 1950 to 1960, housing growth in the North Central Forest (26.1%) lagged behind the statewide average (40.4%) but drew closer to statewide housing growth through the 1960s (22.7% in North Central Forest counties versus 27.2% statewide) and surpassed it in the 1970s (32.2% in North Central Forest counties versus 30.3% statewide) (USCB 2009). Since then, housing growth in the North Central Forest counties has approximated that of the state as a whole. Within individual counties, only Florence, Washburn, and Forest counties have exceeded the statewide average for housing growth from 1950 to 2000. Housing development in the North Central Forest counties has grown independently of population growth, largely due to the proliferation of seasonal housing even while resident populations left these counties for greater opportunities in larger population centers.

■ **Housing Values.** Median housing values in 2005–2009 in North Central Forest counties were consistently much lower than in the state as a whole (\$166,100) (USCB 2012b). This includes the three lowest-ranking counties in the state in terms of housing values: Ashland (\$100,300), Iron (\$102,800), and Rusk (\$107,300). The remaining North Central Forest counties have relatively low housing values ranging from Langlade County's \$107,700 to Sawyer County's \$167,800.

The Economy

North Central Forest counties support higher levels of government jobs and service jobs based primarily on recreation and tourism compared to the state as a whole. Wages in the service sector tend to be lower than in other economic sectors with a higher proportion of part-time and seasonal jobs. Conversely, manufacturing sector jobs associated with higher wages are also highly represented in the North Central Forest counties. There is a net in-migration of retirement age adults and out-migration of young adults, with profound implications for the available workforce. Average age of the population is increasing as a result. Per capita and household incomes and average wages per job are lower in the North Central Forest counties while unemployment rates are higher than in the state as a whole.

Income

■ **Per Capita Income.** Total personal income for the 13 North Central Forest counties in 2006 was \$6.55 billion (3.4% of the state total), with Chippewa County contributing roughly a quarter of that total (\$1.64 billion) (USDC BEA 2006). Per capita income in 2006 (\$26,738) was lower than the statewide average of \$34,405 (Table 12.9). Rusk County (\$22,349) had the state's second lowest per capita income, while the best county in the North Central Forest in terms of per capita income (Lincoln with \$28,252) ranks only 37th statewide.

■ **Household Income.** All North Central Forest counties in 2005 had lower median household income levels than the statewide average (\$47,141) (USCB 2009). Median household incomes in the North Central Forest counties ranged from Chippewa County's \$45,062 to Iron County's \$34,806, and six of the seven lowest median household income counties in the

state are within the North Central Forest counties, according to U.S. Census Bureau estimates.

■ **Earnings Per Job.** Similar to household income, earnings per job in North Central Forest counties are among the lowest in the state. In 2006, average earnings per job for North Central Forest counties were \$27,862 compared to the average of \$36,142 statewide (USDC BEA 2006). Florence County (\$20,584), Bayfield County (\$22,403), and Iron County (\$24,634) had the state's three lowest wages per job figures. Earnings per job in the remaining North Central Forest counties ranged from \$25,190 in Forest County to \$30,496 in Lincoln County.

Unemployment

The North Central Forest counties each had higher 2006 average annual unemployment rates than the state as a whole and had a combined unemployment rate of 5.8% (Table 12.9; USDL BLS 2006). Taylor County's unemployment rate (5.0%) was lowest among North Central Forest counties, and Iron County (8.2%) was highest, compared to the state average of 4.7%. Unemployment rates became much higher throughout the state after 2008 but have become lower again.

Poverty

■ **Poverty Rates.** The U.S. Census Bureau estimated that the North Central Forest counties' combined poverty rate in 2005 for all people (10.7%) was close to the state average (10.2%) (USCB 2009). Poverty rates for all people were lower in 2005 than the statewide figure in Lincoln, Chippewa, Price, and Sawyer counties. The remaining North Central Forest counties had poverty rates ranging from 10.4% in Florence County to Iron County's 14.5%, fifth highest among Wisconsin counties.

Table 12.9. Economic indicators for the North Central Forest counties and Wisconsin.

	Per capita income ^a	Average earnings per job ^a	Unemployment rate ^b	Poverty rate ^c
Wisconsin	\$34,405	\$36,142	4.7%	10.2%
Ashland	\$26,705	\$28,991	6.1%	14.8%
Bayfield	\$27,066	\$22,403	6.4%	11.2%
Chippewa	\$27,459	\$29,417	5.2%	9.2%
Florence	\$28,210	\$20,584	6.6%	10.4%
Forest	\$23,857	\$25,190	6.6%	12.9%
Iron	\$25,469	\$24,634	8.2%	14.5%
Langlade	\$27,575	\$27,152	6.0%	11.8%
Lincoln	\$28,252	\$30,496	5.5%	8.2%
Price	\$28,160	\$27,970	5.5%	9.3%
Rusk	\$22,349	\$25,697	6.6%	14.2%
Sawyer	\$27,646	\$26,129	6.4%	13.5%
Taylor	\$25,465	\$29,422	5.0%	9.9%
Washburn	\$25,095	\$25,881	6.6%	11.3%
North Central Forest counties	\$26,738	\$27,862	5.8%	10.7%

^aSource: U.S. Bureau of Economic Analysis, 2006 figures.

^bSource: U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics, 2006 figures.

^cSource: U.S. Bureau of the Census, Small Area Income and Poverty Estimates, 2005 figures.

■ **Child Poverty Rates.** Compared to the statewide average (14%), 2005 estimates of poverty rates for people under age 18 were higher in eight North Central Forest counties (USCB 2009). These counties' child poverty rates ranged from Rusk (20.6%) to Langlade (16.9%). Another group of five North Central Forest counties had comparatively lower child poverty rates, ranging from Chippewa (13.6%) to Lincoln (11.8%).

Residential Property Values

Average residential property values in the combined North Central Forest counties (\$116,751 per housing unit) were lower than the statewide average (\$134,021 per housing unit). However, residential property values were highly variable between North Central Forest counties, ranging from very low values in Taylor County (\$75,341) to relatively high values in Bayfield County (\$149,885), Washburn County (\$162,313), and Sawyer County (\$187,106) (Table 12.10). Residential property in these higher valued counties can be attributed to the prevalence of vacation and second home properties associated with their many lakes. The value in these properties is not necessarily reflected in the value of the homes but more in the land itself.

Important Economic Sectors

North Central Forest counties together provided 130,241 jobs in 2007, or about 3.7% of the total employment in Wisconsin (Table 12.11; MIG 2009). Chippewa County (31,818 jobs in 2007) had more than twice the employment of the next North Central Forest county, which is Lincoln County (15,647 jobs). The remaining North Central Forest counties provided comparatively few jobs, ranging from 12,498 in Langlade County to just 1,360 jobs in Florence County. The

Government sector (15.3% of all employment in North Central Forest counties) is the leading source of employment in North Central Forest counties followed in importance by the Tourism-related sector (11.1%), Manufacturing (non-wood) (10.5%), and Retail Trade (10.0%). Economic sectors of secondary importance included Health Care and Social Services (8.7%) and Forest Products and Processing (8.5%). For definitions of economic sectors, see the North American Industry Classification System web page (USCB 2013).

Importance of economic sectors within the North Central Forest counties when compared to the rest of the state was evaluated using an economic base analysis to yield a standard metric called a location quotient (Quintero 2007). Economic base analysis compares the percentage of all jobs in an ecological landscape county approximation for a given economic sector to the percentage of all jobs in the state for the same economic sector. For example, if 10% of the jobs within an ecological landscape county approximation are in the manufacturing sector and 10% of all jobs in the state are in the manufacturing sector, then the location quotient would be 1.0, indicating that this ecological landscape county approximation contributes jobs to the manufacturing sector at the same rate as the statewide average. If the location quotient is greater than 1.0, the ecological landscape county approximation is contributing more jobs to the sector than the state average. If the location quotient is less than 1.0, the ecological landscape county approximation is contributing fewer jobs to the sector than the state average.

When compared with the rest of the state, the North Central Forest counties had eight sectors of employment with quotients higher than 1.0 (Figure 12.24, Appendix 12.I). True to their rural character, North Central Forest counties are heavily dependent on raw material/resource-based

Table 12.10. Property values for the North Central Forest counties and Wisconsin, assessed in 2006 and collected in 2007.

	Residential property value	Housing units	Residential property value per housing unit
Wisconsin	\$340,217,559,700	2,538,538	\$134,021
Ashland	\$831,759,000	9,367	\$88,797
Bayfield	\$1,941,013,500	12,950	\$149,885
Chippewa	\$2,913,489,000	25,717	\$113,290
Florence	\$404,585,000	4,608	\$87,801
Forest	\$890,941,000	8,845	\$100,728
Iron	\$680,404,400	6,063	\$112,222
Langlade	\$1,114,305,400	12,012	\$92,766
Lincoln	\$1,651,000,400	15,769	\$104,699
Price	\$871,723,400	10,202	\$85,446
Rusk	\$720,172,100	8,155	\$88,310
Sawyer	\$2,877,510,200	15,379	\$187,106
Taylor	\$690,350,400	9,163	\$75,341
Washburn	\$1,963,992,500	12,100	\$162,313
North Central Forest counties	\$17,551,246,300	150,330	\$116,751

Sources: Wisconsin Department of Revenue 2006–2007 property tax master file (except housing units); housing units: U. S. Census Bureau estimates for July 1, 2006.

Table 12.11. Total and percentage of jobs in 2007 in each economic sector within the North Central Forest (NCF) counties. The economic sectors providing the highest percentage of jobs in the North Central Forest counties are highlighted in blue.

Industry sector	WI employment	% of WI total	NCF counties employment	% of NCF counties total
Agriculture, Fishing & Hunting	110,408	3.1%	8,679	6.7%
Forest Products & Processing	88,089	2.5%	11,085	8.5%
Mining	3,780	0.1%	373	0.3%
Utilities	11,182	0.3%	249	0.2%
Construction	200,794	5.6%	8,385	6.4%
Manufacturing (non-wood)	417,139	11.7%	13,724	10.5%
Wholesale Trade	131,751	3.7%	2,977	2.3%
Retail Trade	320,954	9.0%	13,042	10.0%
Tourism-related	399,054	11.2%	14,505	11.1%
Transportation & Warehousing	108,919	3.1%	4,738	3.6%
Information	57,081	1.6%	1,207	0.9%
Finance & Insurance	168,412	4.7%	3,483	2.7%
Real Estate, Rental & Leasing	106,215	3.0%	2,013	1.5%
Professional, Science & Tech Services	166,353	4.7%	2,508	1.9%
Management	43,009	1.2%	590	0.5%
Administrative & Support Services	166,405	4.7%	2,061	1.6%
Private Education	57,373	1.6%	1,813	1.4%
Health Care & Social Services	379,538	10.7%	11,388	8.7%
Other Services	187,939	5.3%	7,557	5.8%
Government	430,767	12.1%	19,865	15.3%
Totals	3,555,161		130,241	3.7%

Source: IMPLAN, © MIG, Inc. 2009.

industries. North Central Forest counties have the greatest location quotient for the Forest Products and Processing sector among all ecological landscape county approximations for that sector and among all sectors. The North Central Forest counties' 11,085 jobs in Forest Products and Processing represent 12.6% of all jobs in that sector. Other sectors providing a percentage of jobs higher than the state average, listed in order of their relative importance in the North Central Forest, are Mining; Agriculture, Fishing, and Hunting; Government; Transportation and Warehousing; Construction; Retail Trade; and Other Services.

The Other Services sector consists primarily of equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photo finishing services, temporary parking services, and dating services. The Tourism-related sector includes relevant subsectors within Retail Trade, Passenger Transportation, and Arts, Entertainment, and Recreation. The Tourism-related sector also includes all Accommodation and Food Services (Marcouiller and Xia 2008). The Forest Products and Processing sector includes sectors in logging, pulp and paper manufacturing, primary wood manufacturing (e.g., sawmills), and secondary wood manufacturing (e.g., furniture manufacturing).

Urban Influence

The USDA Economic Research Service (USDA ERS) divides counties into 12 groups on a continuum of urban influence, with 1 representing large metropolitan areas, 2 representing smaller metropolitan areas, and the remaining classes from 3 to 12 representing nonmetropolitan counties increasingly less populated and isolated from urban influence (USDA ERS 2012b). The concept of urban influence assumes population size, urbanization, and access to larger adjacent economies are crucial elements in evaluating potential of local economies. With the exception of Chippewa County, the North Central Forest counties are composed of nonmetropolitan (rural) counties with varying degrees of "influence" from adjacent urban areas. Several North Central Forest counties rank among the most isolated from urban influence: Iron and Sawyer counties are classified as class 12 counties, Ashland and Price counties are class 11 counties, and Forest County ranks as a class 10 county.

Economic Types

Based on the assumption that knowledge and understanding of different types of rural economies and their distinctive economic and sociodemographic profiles can aid rural policymaking, the USDA ERS classifies counties in one of six mutually exclusive categories: farming-dependent counties, mining-

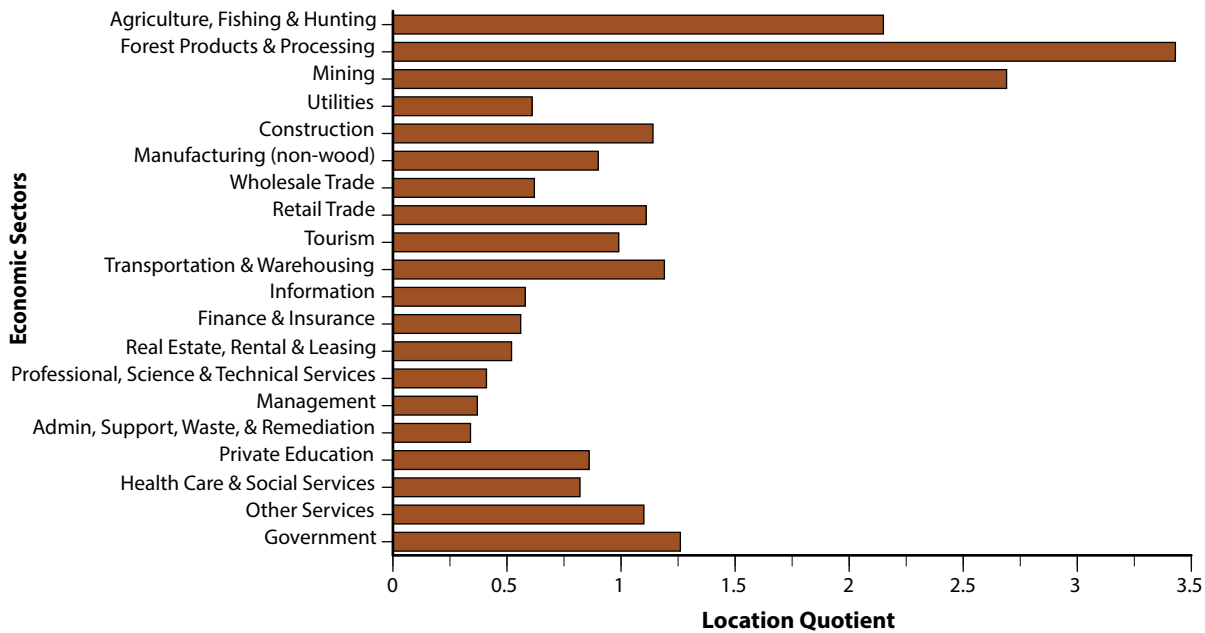


Figure 12.24. Importance of economic sectors within the North Central Forest counties when compared to the rest of the state. If the location quotient is greater than 1.0, the North Central Forest counties are contributing more jobs to that economic sector than the state average. If the location quotient is less than 1.0, the North Central Forest counties are contributing fewer jobs to that economic sector than the state average.

dependent counties, manufacturing-dependent counties, government-dependent counties, service-dependent counties, and nonspecialized counties (USDA ERS 2012a). Five North Central Forest counties (Chippewa, Lincoln, Price, Rusk, and Taylor) were classified as manufacturing-dependent in 2004 according to the USDA ERS economic specialization definitions. The remaining North Central Forest counties were classified as nonspecialized.

Policy Types

The USDA ERS classifies counties according to “policy types” deemed especially relevant to rural development policy (USDA ERS 2012a). Of particular interest in the North Central Forest counties are the categories of “nonmetro recreation” counties (rural counties classified using a combination of factors, including share of employment or share of earnings in recreation-related industries in 1999, share of seasonal or occasional use housing units in 2000, and per capita receipts from motels and hotels in 1997) and “retirement destination” counties. In 2004, Bayfield, Price, and Sawyer counties were classified as nonmetro recreation counties, indicating economic dependence especially upon an influx of tourism and recreational dollars. Florence, Forest, Iron, and Washburn counties were classified as both nonmetro recreation counties and retirement destination counties. Retirement destination counties (those in which the number of residents 60 and older grew by 15% or more between 1990 and 2000 due to immigration) are dependent on an influx of an aging population and have particular needs for health care and services specific to that population.

Integrated Opportunities for Management

Use of natural resources for human needs within the constraints of sustainable ecosystems is an integral part of ecosystem management. Integrating ecological management with socioeconomic programs or activities can result in efficiencies in land use, tax revenues, and private capital. This type of integration can also help generate broader and deeper support for sustainable ecosystem management. However, any human modification or use of natural communities has trade-offs that benefit some species and harm others. Even relatively benign activities such as ecotourism will have impacts on the ecology of an area. Trade-offs caused by management actions need to be carefully weighed when planning management to ensure that some species are not being irreparably harmed. Maintaining healthy, sustainable ecosystems provides many benefits to people and our economy. The development of ecologically sound management plans should save money and sustain natural resources in the long run.

Principles of integrating natural resources and socioeconomic activities are similar across the state. See “Integrated Ecological and Socioeconomic Opportunities” in Chapter 6, “Wisconsin’s Ecological Features and Opportunities for Management.” That section offers suggestions on how and when ecological and socioeconomic needs might be integrated and gives examples of the types of activities that might work together when planning the management of natural resources within a given area.



Appendices

Appendix 12.A. Watershed water quality summary for the North Central Forest Ecological Landscape.

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressors ^a (Range = Poor/Fair/Good/Very Good/Excellent)
BR12	Trappers and Pine Creeks	85,955	Fair to Good; streambank pasturing > Hab/Sed; barnyard NPS > bacteria; erosion; chlorine toxicity
BR13	Black and Little Black rivers	102,919	Barnyard/urban NPS > Hab/low D.O./bacteria/Temp; chlorine toxicity; streambank pasturing > Hab/Sed
CW22	Upper Eau Claire River	141,672	Poor to V Good; livestock grazing/gravel mine > erosion/NPS/GW nitrate; many ERW streams; lakes P-sensitive
CW26	Upper Rib River	126,122	Fair to Excellent; 60% forest/40% Agr.; NPS; gravel mining; lakes need baseline monitoring
GB11	Upper Peshtigo River	216,530	Good to Excellent; beaver dams > Sed/Hab/Temp/Flux; impoundments > Sed/Hg
GB12	Otter Creek and Rat River	90,565	V Good to Excellent; beaver dams > Sed/Hab/Temp/Flux
GB14	Pike River	182,234	V Good to Excellent; most streams ORW; heavily forested; forest mgmt > NPS; beaver dams > Sed/Hab/Temp; mesotrophic lakes
GB16	Pine River	219,247	V Good to Excellent; Agr NPS; beaver dams > Sed/Hab/Temp/Flux/fish impediment; forest mgmt > NPS; need lakes data
GB17	Popple River	148,000	Excellent; nearly all ORW streams; beaver dams > Sed/Hab/Temp; need lakes data
GB18	Brule River	124,630	V Good to Excellent; many ORW streams; beaver dams > Sed/Hab/Temp/Flux/fish impediment; forest mgmt > NPS; need lakes data
LC16	S. Fork Eau Claire River	146,871	Good; beaver dams/streambank grazing > Hab/Sed/Temp; impoundments: eutrophic; Hg
LC17	N. Fork Eau Claire River	131,767	Good to V Good; streambank grazing > Hab; low D.O.; impoundment NPS > weeds/algae
LC18	Duncan Creek	122,522	Fair to Excellent; streambank grazing > low D.O./Flux/ Sed; lakes: urban NPS > Sed/algae/weedy
LS10	White River	234,339	V Good to Excellent; many ORW/ERW; forest mgmt > NPS; beaver dams > Sed/Hab/Temp; streambank erosion; small high-quality lakes
LS11	Potato River	89,5547	V Good; several ERW; forestry/beaver dams > Sed/Hab; need lakes data
LS12	Marengo River	139,219	V Good; several ERW; streambank pasturing/beaver dams > erosion/Sed/Hab; need lakes data
LS13	Tyler Forks	50,409	Good to V Good; some ERW; barnyards/cropland/streambank grazing > Sed/Hab/nutrients/Temp
LS14	Upper Bad River	86,198	V Good; streambank pasturing/beaver dams > erosion/Sed/Hab; industrial point source > weedy
LS15	Montreal River	144,807	V Good; Several ERW; Hg in Sed; Streambank pasturing > erosion/Sed/Hab
LS16	Presque Isle River	69,159	V Good; stream data needed; many lakes & wetlands; lake seds have atmospheric Hg; lakes data pending
SC18	Upper St. Croix/Eau Claire R.	177,851	Good to Excellent; no stream stressors listed; oligotrophic to mesotrophic lakes
SC19	Lower Namekagon River ^b	153,176	Good to V Good; beaver dams > Temp/Hab; lakes mesotrophic
SC20	Totagatic River	211,156	Good to Excellent; no stream stressors listed; oligotrophic to mesotrophic lakes

Continued on next page

Appendix 12.A, continued.

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressor^a (Range = Poor/Fair/Good/Very Good/Excellent)
SC21	Trego Lake - Middle Namekagon River	172,087	Good to V Good; streambank pasturing/beaver dams > Hab/Temp; lakes: mesotrophic to eutrophic
SC22	Upper Namekagon River	126,592	V Good to Excellent; many ORW/ERW; beaver dam > Hab; oligotrophic to mesotrophic lakes
UC01	Holcombe Flowage	109,043	Good to V Good; 70% forest; sand has covered cobble river substrate; some NPS; undevel. softwater seepage & acid bog lakes
UC02	Lower Jump River	86,858	V Good; impoundments > low D.O./winterkill; NPS threat
UC03	Middle Jump River	147,126	V Good; cranberry bed > Sed & gravel mine discharge needs monitoring
UC04	Upper South Fork Jump River	206,344	Fair to Excellent; Agr NPS > low D.O. on one trib; some lightly developed softwater seepage & undevel acid bog lakes
UC05	Main Creek	100,646	Fair; 24% Agr; streambank pasturing > heavy Sed/Hab/algae; Flux; Holcombe Flowage eutrophic
UC06	Deer Tail Creek	40,344	Fair; streambank pasturing > Hab/low D.O.; Flux
UC07	Lower Flambeau River	82,320	Good to V Good; 57% forest/15% Agr/16% wetland; Agr/urban NPS; many rare sp; dams > Hg Sed; residual paper mill impacts?
UC08	Lower S. Fork Flambeau River	128,099	Excellent; 57% forest/33% wetland/3% Agr; rare species require V Good water quality; Pvt land from Chequamegon National Forest to Flambeau State Forest needs protection for water quality
UC09	Elk River	167,116	Good; Beaver dams; plating metals; gravel mine; dams; failing septs
UC10	Upper S. Fork Flambeau River	178,549	V Good to Excellent; 84% Forest/Wetland; many rare species; Agr; septage spreading/cranberries > NPS nutrients; Flux;
UC11	Lower N. Fork Flambeau River	98,541	V Good to Excellent; 70% forest/22% wetland; industrial sed residue; beaver dams > Hab/Sed
UC12	Butternut Creek	49,706	Good; road Sed; past industrial spills; Butternut Lake eutrophic
UC13	Upper N. Fork Flambeau River	101,257	Good to Excellent; 84% forest/wetland; rare species require V Good water quality; dams > Sed/Hab
UC14	Flambeau Flowage	158,196	Good to V Good; 80% forest/wetland; point source nutrients; beaver dams; failing septs/lawn NPS > developed lakes eutrophic
UC15	Bear River	93,086	V Good; 80% forest/wetland; cranberry impoundments
UC16	Manitowish River ^b	171,904	V Good to Excellent; 80% forest/wetland; several rare species require V Good water quality; erosion; beaver dams
UC17	Soft Maple and Hay creeks	113,123	Fair to V Good; 22% Agr; horse/cattle grazing > lack of bank cover > erosion/Hab/Sed; barnyard runoff > NPS nutrients
UC18	Thornapple River	147,184	Good to Excellent; 88% forest/wetland; healthy macroinvertebrate pop; sturgeon spawning
UC19	Weirgor Cr. and Brunet River	207,357	Good to Excellent; 7% Agr/83% forest/wetland; forestry BMP lacking > road sed; beaver dams > Hab; Agr
UC20	Couderay River	135,838	V Good; beaver dams > Hab; dams block fish; Flux; pasturing in southern area; streams need biol surveys; large, high-quality lakes & LCO lands
UC21	East Fork Chippewa River	195,300	V Good; 91% forest/wetland; beaver dams; streams need biol & water quality surveys; dam; lakes mesotrophic
UC22	Lake Chippewa	117,057	V Good to Excellent; 77% forest & wetland; dam; large, high-quality mesotrophic lakes; lake & stream WQ data needs updating
UC23	West Fork Chippewa River	182,258	V Good to Excellent; 91% forest & wetland; beaver dams > Hab; lakes need trophic status & critical habitat surveys
UW30	Prairie River	168,954	V Good to Excellent; Beaver dams/ditching > Hab/Sed/Temp/Flux; seepage & drainage lakes: data needed

Continued on next page

Appendix 12.A, continued.

Watershed no.	Watershed name	Area (acres)	Overall water quality and major stressor ^a (Range = Poor/Fair/Good/Very Good/Excellent)
UW31	Copper River	65,949	Good to V Good; cranberry Agr > pesticides; gravel mine; seepage & drainage lakes: data needed
UW32	New Wood River	74,070	Good to V Good; beaver dams > Temp/Hab; NPS > Sed; few lakes
UW33	Noisy and Pine creeks	114,783	Data not available
UW34	Spirit River	108,175	Data not available
UW35	Somo River	90,435	Data not available
UW36	Lower Tomahawk River	85,676	Data not available
UW37	Middle Tomahawk River	149,313	Data not available
WR18	Wolf River-Langlade, and Evergreen River	115,035	Good to Excellent; 60%–100% forested tribs; beaver dams; heavy rec. use on Wolf River > bank compaction; seepage lakes mesotrophic to eutrophic
WR19	Lily River	134,058	V Good to Excellent; dam > passage impaired; beaver dams > Temp; log roads > erosion
WR20	Upper Wolf River and Post Lake	130,118	V Good to Excellent; dam > low D.O.; beaver dams > Temp; Sed

Source: Wisconsin DNR Bureau of Watershed Management data.

^aBased on Wisconsin DNR watershed water quality reports.

^bOnly a small fraction of this watershed lies within this ecological landscape, so overall impacts of land uses within the landscape are unlikely to impact water quality within the watershed to any appreciable degree.

Abbreviations:

Agr = Agricultural.

BMP = Best management practices.

D.O. = Dissolved oxygen.

ERW = Exceptional Resource Water (very good to excellent water quality, with point source discharges).

Flux = Abnormal highs and lows in stream flow fluctuation due to lack of groundwater infiltration, etc., often due to loss of forest cover or creation of excessive impermeable surface.

GW = Groundwater (without modifiers, indicates high nitrates, radon, manganese, or other negative use condition).

Hab = Stream habitat damage.

Hg = Mercury contamination of fish, mainly deposited by coal combustion, or sometimes by industry.

NPS = Nonpoint source pollutants, such as farm or parking lot runoff, or septic system leakage.

ORW = Outstanding Resource Water (very good to excellent water quality, with no point source discharges).

Sed = Excess sedimentation.

Temp = Elevated temperatures in some stream reaches.

Tribes = Streams that are tributary to the stream(s) after which the watershed is named.

> = Yields, creates, or results in (the listed impacts).

Appendix 12.B. Forest habitat types in the North Central Forest Ecological Landscape.

The forest habitat type classification system (FHTCS) is a site classification system based on the floristic composition of plant communities. The system depends on the identification of potential climax associations, repeatable patterns in the composition of the understory vegetation, and differential understory species. It groups land units with similar capacity to produce vegetation. The floristic composition of the plant community is used as an integrated indicator of those environmental factors that affect species reproduction, growth, competition, and community development. This classification system enables the recognition and classification of ecologically similar landscape units (site types) and forest plant communities (vegetation associations).

A forest habitat type is an aggregation of sites (units of land) capable of producing similar late-successional (potential climax) forest plant communities. Each recognizable habitat type represents a relatively narrow segment of environmental variation that is characterized by a certain limited potential for vegetation development. Although at any given time, a habitat type can support a variety of disturbance-induced (seral) plant communities, the ultimate product of succession is presumed to be a similar climax community. Field identification of a habitat type provides a convenient label (habitat type name) for a given site, and places that site in the context of a larger group of sites that share similar ecological traits. Forest habitat type groups more broadly combine individual habitat types that have similar ecological potentials.

Individual forest cover types classify current overstory vegetation, but these associations usually encompass a wide range of environmental conditions. In contrast, individual habitat types group ecologically similar sites in terms of vegetation potentials. Management interpretations can be refined and made significantly more accurate by evaluating a stand in terms of the current cover type (current dominant vegetation) plus the habitat type (potential vegetation).

Habitat types	Description of forest habitat types found in the North Central Forest Ecological Landscape.
ATM	<i>Acer saccharum</i> - <i>Tsuga canadensis</i> / <i>Maianthemum canadense</i> Sugar maple-Eastern hemlock/Wild lily-of-the-valley
ATD	<i>Acer saccharum</i> - <i>Tsuga canadensis</i> / <i>Dryopteris spinulosa</i> Sugar maple-Eastern hemlock/Spinulose shield fern
AOCa	<i>Acer saccharum</i> / <i>Osmorhiza claytoni</i> - <i>Caulophyllum thalictroides</i> Sugar maple/Sweet cicely-blue cohosh
TMC	<i>Tsuga canadensis</i> / <i>Maianthemum canadense</i> - <i>Coptis groenlandica</i> Eastern hemlock/Wild lily-of-the-valley-Goldthread
ArAbCo	<i>Acer rubrum</i> - <i>Abies balsamea</i> / <i>Cornus canadensis</i> Red maple-Balsam fir/Bunchberry
AH	<i>Acer saccharum</i> / <i>Hydrophyllum virginianum</i> Sugar maple/Virginia waterleaf
AAt	<i>Acer saccharum</i> / <i>Athyrium filix-femina</i> Sugar maple/Lady fern
ACaCi	<i>Acer saccharum</i> / <i>Caulophyllum thalictroides</i> - <i>Circaea quadrisulcata</i> Sugar maple/Blue cohosh-Enchanter's nightshade
ACal	<i>Acer saccharum</i> / <i>Caulophyllum thalictroides</i> - <i>Impatiens capensis</i> Sugar maple/Blue cohosh-Jewelweed
AHI	<i>Acer saccharum</i> / <i>Hydrophyllum virginianum</i> - <i>Impatiens capensis</i> Sugar maple/Virginia waterleaf-Jewelweed
ASal	<i>Acer saccharum</i> / <i>Sanguinaria canadensis</i> - <i>Impatiens capensis</i> Sugar maple/Bloodroot-Jewelweed
ArAbVc	<i>Acer rubrum</i> - <i>Abies balsamea</i> / <i>Vaccinium angustifolium</i> - <i>Cornus canadensis</i> Red maple-Balsam fir/Blueberry-Bunchberry
AVVb	<i>Acer saccharum</i> / <i>Vaccinium angustifolium</i> - <i>Viburnum acerifolium</i> Sugar maple/Blueberry-Maple-leaved Viburnum
AVDe	<i>Acer saccharum</i> / <i>Vaccinium angustifolium</i> - <i>Desmodium glutinosum</i> Sugar maple/Blueberry-Pointed-leaved tick trefoil
PARVAa	<i>Pinus strobus</i> - <i>Acer rubrum</i> / <i>Vaccinium angustifolium</i> - <i>Aralia nudicaulis</i> White pine-Red maple/Blueberry-Wild sarsaparilla
PARVAm	<i>Pinus strobus</i> - <i>Acer rubrum</i> / <i>Vaccinium angustifolium</i> - <i>Amphicarpa bracteata</i> White pine-Red maple/Blueberry-Hog peanut

Source: Kotar et al. (2002).

Appendix 12.C. The Natural Heritage Inventory (NHI) table of rare species and natural community occurrences (plus a few miscellaneous features tracked by the NHI program) for the North Central Forest (NCF) Ecological Landscape in November 2009. See the Wisconsin Natural Heritage Working List online for the most current status (<http://dnr.wi.gov>, keyword "NHI").

Scientific name (common name)	Lastobs Date	EOs ^a in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
MAMMALS								
<i>Canis lupus</i> (gray wolf)	2008	106	204	52%	S2	G4	SC/FL	LE
<i>Martes americana</i> (American marten)	2008	2	3	67%	S3	G5	END	
<i>Myotis septentrionalis</i> (northern long-eared bat) ^b	2007	1	9	11%	S3	G4	SC/N	
<i>Napaeozapus insignis</i> (woodland jumping mouse)	1995	12	15	80%	S2S3	G5	SC/N	
<i>Sorex arcticus</i> (arctic shrew)	1995	9	31	29%	S3S4	G5	SC/N	
<i>Sorex hoyi</i> (pygmy shrew)	1995	14	39	36%	S3S4	G5	SC/N	
<i>Sorex palustris</i> (water shrew)	1995	7	13	54%	S2S3	G5	SC/N	
<i>Spermophilus franklinii</i> (Franklin's ground squirrel)	1990	1	12	8%	S2	G5	SC/N	
BIRDS^c								
<i>Accipiter gentilis</i> (Northern Goshawk)	2009	73	141	52%	S2B,S2N	G5	SC/M	
<i>Asio otus</i> (Long-eared Owl)	2000	1	8	13%	S2B	G5	SC/M	
<i>Bartramia longicauda</i> (Upland Sandpiper)	1997	1	54	2%	S2B	G5	SC/M	
<i>Botaurus lentiginosus</i> (American Bittern)	2005	5	41	12%	S3B	G4	SC/M	
<i>Buteo lineatus</i> (Red-shouldered Hawk)	2009	27	301	9%	S3S4B,S1N	G5	THR	
<i>Catharus ustulatus</i> (Swainson's Thrush)	2004	4	18	22%	S2B	G5	SC/M	
<i>Chlidonias niger</i> (Black Tern)	2008	4	60	7%	S2B	G4	SC/M	
<i>Contopus cooperi</i> (Olive-sided Flycatcher)	2008	3	4	75%	S2B	G4	SC/M	
<i>Coturnicops noveboracensis</i> (Yellow Rail)	2005	4	22	18%	S1B	G4	THR	
<i>Cygnus buccinator</i> (Trumpeter Swan)	1999	2	22	9%	S4B	G4	SC/M	
<i>Dendroica caerulescens</i> (Black-throated Blue Warbler) ^d	2008	12	27	44%	S3B	G5	SC/M	
<i>Dendroica cerulea</i> (Cerulean Warbler) ^d	2003	12	92	13%	S2S3B	G4	THR	
<i>Dendroica tigrina</i> (Cape May Warbler) ^d	2008	7	26	27%	S3B	G5	SC/M	
<i>Falci pennis canadensis</i> (Spruce Grouse)	2009	24	33	73%	S1S2B,S1S2N	G5	THR	
<i>Haliaeetus leucocephalus</i> (Bald Eagle)	2005	324	1286	25%	S4B,S2N	G5	SC/P	
<i>Lanius ludovicianus</i> (Loggerhead Shrike)	1978	1	31	3%	S1B	G4	END	
<i>Oporornis agilis</i> (Connecticut Warbler)	2003	3	27	11%	S2S3B	G4	SC/M	
<i>Pandion haliaetus</i> (Osprey)	2008	190	733	26%	S4B	G5	SC/M	
<i>Picoides arcticus</i> (Black-backed Woodpecker)	2008	8	17	47%	S2B	G5	SC/M	
<i>Poecile hudsonicus</i> (Boreal Chickadee)	2008	15	25	60%	S2S3B	G5	SC/M	
<i>Seiurus motacilla</i> (Louisiana Waterthrush) ^d	2002	1	34	3%	S3B	G5	SC/M	
<i>Spiza americana</i> (Dickcissel)	2003	1	46	2%	S3B	G5	SC/M	
<i>Strix nebulosa</i> (Great Gray Owl)	2000	3	4	75%	S1B	G5	SC/M	
<i>Tyto alba</i> (Barn Owl)	1979	1	29	3%	S1B,S1N	G5	END	
<i>Wilsonia canadensis</i> (Canada Warbler) ^d	2008	3	20	15%	S3B	G5	SC/M	
HERPTILES								
<i>Diadophis punctatus edwardsii</i> (northern ring-necked snake)	2000	8	23	35%	S3?	G5T5	SC/H	
<i>Emydoidea blandingii</i> (Blanding's turtle)	2008	14	316	4%	S3	G4	THR	
<i>Glyptemys insculpta</i> (wood turtle)	2008	70	262	27%	S2	G4	THR	
<i>Hemidactylium scutatum</i> (four-toed salamander)	2005	25	63	40%	S3	G5	SC/H	
<i>Lithobates catesbeianus</i> (American bullfrog)	2006	6	70	9%	S3	G5	SC/H	
<i>Lithobates septentrionalis</i> (mink frog)	2008	1	7	14%	S3S4	G5	SC/H	

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Appendix 12.C, continued.

Scientific name (common name)	Lastobs date	EOs ^a in in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
FISHES								
<i>Acipenser fulvescens</i> (lake sturgeon)	1997	9	99	9%	S3	G3G4	SC/H	
<i>Clinostomus elongatus</i> (redside dace)	1995	15	96	16%	S3	G3G4	SC/N	
<i>Erimyzon sucetta</i> (lake chubsucker)	2008	1	85	1%	S3	G5	SC/N	
<i>Etheostoma microperca</i> (least darter)	1991	15	83	18%	S3	G5	SC/N	
<i>Fundulus diaphanus</i> (banded killifish)	1976	1	105	1%	S3	G5	SC/N	
<i>Lepomis megalotis</i> (longear sunfish)	1978	8	25	32%	S2	G5	THR	
<i>Moxostoma valenciennesi</i> (greater redhorse)	1996	7	56	13%	S3	G4	THR	
<i>Notropis anogenus</i> (pugnose shiner)	1976	2	49	4%	S2	G3	THR23	
<i>Notropis nubilus</i> (Ozark minnow)	1976	2	24	8%	S2	G5	THR	
<i>Notropis texanus</i> (weed shiner)	1978	4	45	9%	S3	G5	SC/N	
<i>Opsopoeodus emiliae</i> (pugnose minnow)	1979	1	31	3%	S3	G5	SC/N	
<i>Percina evides</i> (gilt darter)	1976	2	26	8%	S2	G4	THR	
MUSSELS/CLAMS								
<i>Alasmidonta marginata</i> (elktoe)	1997	11	44	25%	S4	G4	SC/P	
<i>Cyclonaias tuberculata</i> (purple wartyback)	1997	8	16	50%	S1S2	G5	END	
<i>Plethobasus cyphus</i> (bullhead/sheepnose) ^e	1997	2	5	40%	S1	G3	END	C
<i>Pleurobema sintoxia</i> (round pigtoe)	1997	12	50	24%	S3	G4G5	SC/P	
<i>Simpsonaias ambigua</i> (salamander mussel)	1990	1	51	2%	S2S3	G3	THR	
<i>Venustaconcha ellipsiformis</i> (ellipse)	1994	2	28	7%	S2	G4	THR	
MISCELLANEOUS INVERTEBRATES								
<i>Cochlicopa morseana</i> (Appalachian pillar)	1997	2	8	25%	S2	G5	SC/N	
<i>Hendersonia occulta</i> (cherrystone drop)	1997	1	53	2%	S3	G4	THR	
<i>Lyneus brachyurus</i> (holartic clam shrimp)	2002	3	3	100%	S1S3	G5	SC/N	
<i>Striatura ferrea</i> (black striate)	2000	1	14	7%	S2	G5	SC/N	
<i>Vertigo paradoxa</i> (mystery vertigo)	1997	1	6	17%	S1	G4G5Q	SC/N	
<i>Vertigo tridentata</i> (honey vertigo)	2000	1	7	14%	S3	G5	SC/N	
<i>Zoogenetes harpa</i> (boreal top)	1997	1	3	33%	S1	G5	SC/N	
BUTTERFLIES/MOTHS								
<i>Boloria eunomia</i> (bog fritillary)	2003	23	49	47%	S3	G5	SC/N	
<i>Boloria freija</i> (freija fritillary)	2004	7	20	35%	S2S3	G5	SC/N	
<i>Boloria frigga</i> (frigga fritillary)	1996	5	9	56%	S2	G5	SC/N	
<i>Callophrys henrici</i> (Henry's elfin)	2006	1	19	5%	S1S2	G5	SC/N	
<i>Catocala semirelict</i> (semirelict underwing moth)	1988	1	1	100%	S2S3	G5	SC/N	
<i>Erebia discaidalis</i> (red-disked alpine)	2004	4	8	50%	S2	G5	SC/N	
<i>Euphyes bimacula</i> (two-spotted skipper)	1994	1	17	6%	S3	G4	SC/N	
<i>Hesperia comma</i> (Laurentian skipper)	2000	12	15	80%	S3	G5	SC/N	
<i>Hesperia leonardus</i> (Leonard's skipper)	1995	1	29	3%	S3	G4	SC/N	
<i>Lycaeides idas</i> (northern blue)	2003	3	9	33%	S1	G5	END	
<i>Lycaena dorcas</i> (dorcass copper)	2004	15	23	65%	S1S2	G5	SC/N	
<i>Phyciodes batesii lakota</i> (Lakota crescent)	2000	9	24	38%	S3	G4T4	SC/N	
<i>Pieris virginiensis</i> (West Virginia white)	2007	21	25	84%	S3	G3G4	SC/N	
<i>Plebejus saepiolus</i> (greenish blue)	2007	2	2	100%	S2	G5	SC/N	
<i>Satyroides eurydice fumosa</i> (smokey eyed brown)	1994	5	8	63%	S2	G5T3T4	SC/N	
DRAGONFLIES/DAMSELFLIES								
<i>Aeshna clepsydra</i> (mottled darner)	2002	2	9	22%	S2	G4	SC/N	
<i>Aeshna eremita</i> (lake darner)	2002	5	15	33%	S3	G5	SC/N	

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Appendix 12.C, continued.

Scientific name (common name)	Lastobs date	EOs ^a in in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
<i>Chromagrion conditum</i> (aurora damselfly)	1996	1	17	6%	S3	G5	SC/N	
<i>Gomphaeschna furcillata</i> (harlequin darner)	1992	1	1	100%	S2	G5	SC/N	
<i>Gomphus graslinellus</i> (pronghorned clubtail)	1991	1	5	20%	S2	G5	SC/N	
<i>Ischnura posita</i> (fragile forktail)	1989	1	6	17%	S2S3	G5	SC/N	
<i>Nannothemis bella</i> (elfin skimmer)	2003	7	12	58%	S2S3	G4	SC/N	
<i>Ophiogomphus anomalus</i> (extra-striped snaketail)	2003	13	14	93%	S3	G4	END	
<i>Ophiogomphus howei</i> (pygmy snaketail)	2002	13	33	39%	S4	G3	THR	
<i>Ophiogomphus smithi</i> (sand snaketail)	1999	4	28	14%	S2	G2G3	SC/N	
<i>Ophiogomphus susbehcha</i> (Saint Croix snaketail)	1999	2	3	67%	S2	G1G2	END	
<i>Somatochlora forcipata</i> (forcipate emerald)	2000	1	10	10%	S2	G5	SC/N	
<i>Somatochlora incurvata</i> (warpaint emerald)	2000	1	18	6%	S2	G4	END	
<i>Sympetrum danae</i> (black meadowhawk)	1985	1	6	17%	S3	G5	SC/N	

BEETLES

<i>Cicindela longilabris</i> (a tiger beetle)	2002	2	6	33%	S2S3	G5	SC/N	
<i>Cymbiodyta minima</i> (a water scavenger beetle)	2002	1	3	33%	S3	GNR	SC/N	
<i>Gyrinus impressicollis</i> (a whirlygig beetle)	2000	2	2	100%	S2?	GNR	SC/N	
<i>Haliphus leopardus</i> (a crawling water beetle)	2002	2	2	100%	S1S3	GNR	SC/N	
<i>Haliphus pantherinus</i> (a crawling water beetle)	2000	2	13	15%	S2S3	GNR	SC/N	
<i>Hydroporus badiellus</i> (a predaceous diving beetle)	2002	1	7	14%	S3?	GNR	SC/N	
<i>Hydroporus vittatus</i> (a predaceous diving beetle)	1996	1	17	6%	S3	GNR	SC/N	
<i>Hygrotus sylvanus</i> (sylvan hygrotus diving beetle)	2002	1	3	33%	S1	GU	SC/N	
<i>Ilybius discedens</i> (a predaceous diving beetle)	2002	1	3	33%	S3	GNR	SC/N	
<i>Laccobius agilis</i> (a water scavenger beetle)	1996	1	4	25%	S2S3	GNR	SC/N	

MISCELLANEOUS INSECTS/SPIDERS

<i>Banksiola dossuaria</i> (a giant casemaker caddisfly)	2002	1	5	20%	S2S3	G5	SC/N	
<i>Booneacris glacialis</i> (wingless mountain grasshopper)	2006	4	8	50%	S3	G5	SC/N	
<i>Chloealtis abdominalis</i> (Rocky Mountain sprinkled locust)	2006	3	7	43%	S2?	G5	SC/N	
<i>Hebrus burmeisteri</i> (a velvet water bug)	2002	1	2	50%	S2S3	GNR	SC/N	
<i>Isoperla marlynia</i> (a perlodid Stonefly)	1996	1	5	20%	S3	G5	SC/N	
<i>Lepidostoma libum</i> (a lepidostomatid caddisfly)	1996	2	5	40%	S1?	G3G4	SC/N	
<i>Orphulella pelidna</i> (spotted-winged grasshopper)	2004	1	7	14%	S2S3	G5	SC/N	
<i>Trimerotropis verruculata</i> (crackling forest grasshopper)	2006	1	1	100%	S2S3	G5	SC/N	

PLANTS

<i>Adlumia fungosa</i> (climbing fumitory)	1997	2	29	7%	S2	G4	SC	
<i>Amerorchis rotundifolia</i> (round-leaved orchis)	2001	5	9	56%	S2	G5	THR	
<i>Aplectrum hyemale</i> (putty root)	2002	2	17	12%	S2S3	G5	SC	
<i>Arabis missouriensis</i> var. <i>deamii</i> (Deam's rockcress)	1998	3	22	14%	S2	G5?QT3?Q	SC	
<i>Arethusa bulbosa</i> (swamp-pink)	2007	42	96	44%	S3	G4	SC	
<i>Asplenium trichomanes</i> (maidenhair spleenwort)	1996	5	27	19%	S3	G5	SC	
<i>Asplenium viride</i> (green spleenwort)	1997	1	2	50%	S1	G4	END	
<i>Astragalus alpinus</i> (alpine milkvetch)	2006	2	2	100%	S1	G5	END	
<i>Botrychium lunaria</i> (moonwort grape-fern)	1980	1	6	17%	S1S2	G5	END	
<i>Botrychium minganense</i> (Mingan's moonwort)	2002	11	17	65%	S2	G4	SC	
<i>Botrychium mormo</i> (little goblin moonwort)	2007	78	82	95%	S3	G3	END	
<i>Botrychium oneidense</i> (blunt-lobe grape-fern)	2008	30	35	86%	S2	G4Q	SC	
<i>Botrychium rugulosum</i> (rugulose grape-fern)	1992	5	7	71%	S2	G3	SC	
<i>Calamagrostis stricta</i> (slim-stem small-reedgrass)	1996	2	34	6%	S3	G5	SC	
<i>Callitriche hermaphroditica</i> (autumnal water-starwort)	1995	1	11	9%	S2	G5	SC	

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Appendix 12.C, continued.

Scientific name (common name)	Lastobs date	EOs ^a in in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
<i>Calypso bulbosa</i> (fairy slipper)	2004	25	34	74%	S3	G5	THR	
<i>Cardamine pratensis</i> (cuckooflower)	1989	3	42	7%	S3	G5	SC	
<i>Carex assiniboinensis</i> (Assiniboine sedge)	2001	12	33	36%	S3	G4G5	SC	
<i>Carex crawei</i> (Crawe's sedge)	1982	2	24	8%	S3	G5	SC	
<i>Carex folliculata</i> (long sedge)	2002	1	69	1%	S3	G4G5	SC	
<i>Carex gynocrates</i> (northern bog sedge)	2007	13	31	42%	S3	G5	SC	
<i>Carex lenticularis</i> (shore sedge)	2002	1	18	6%	S2	G5	THR	
<i>Carex livida</i> var. <i>radiculis</i> (livid sedge)	2006	3	21	14%	S2	G5T5	SC	
<i>Carex michauxiana</i> (Michaux sedge)	2006	1	8	13%	S2	G5	THR	
<i>Carex pallescens</i> (pale sedge)	2001	21	27	78%	S3	G5	SC	
<i>Carex prasina</i> (drooping sedge)	2000	1	31	3%	S3	G4	THR	
<i>Carex tenuiflora</i> (sparse-flowered sedge)	2007	43	84	51%	S3	G5	SC	
<i>Carex vaginata</i> (sheathed sedge)	2006	9	35	26%	S3	G5	SC	
<i>Ceratophyllum echinatum</i> (prickly hornwort)	2004	53	61	87%	S2	G4?	SC	
<i>Clematis occidentalis</i> (purple clematis)	2004	17	32	53%	S3	G5	SC	
<i>Corallorhiza odorata</i> (autumn coral-root)	1995	2	36	6%	S3	G5	SC	
<i>Cypripedium arietinum</i> (ram's-head lady's-slipper)	2006	3	21	14%	S2	G3	THR	
<i>Cypripedium parviflorum</i> var. <i>makasin</i> (northern yellow lady's-slipper)	2007	5	78	6%	S3	G5T4Q	SC	
<i>Cypripedium reginae</i> (showy lady's-slipper)	2007	19	99	19%	S3	G4	SC	
<i>Cystopteris laurentiana</i> (Laurentian bladder fern)	1979	1	11	9%	S2	G3	SC	
<i>Deschampsia cespitosa</i> (tufted hairgrass)	1997	1	17	6%	S2	G5	SC	
<i>Deschampsia flexuosa</i> (crinkled hairgrass)	1972	1	44	2%	S3	G5	SC	
<i>Diplazium pycnocarpon</i> (glade fern)	1999	2	12	17%	S2	G5	SC	
<i>Drosera linearis</i> (slenderleaf sundew)	2006	1	5	20%	S1	G4	THR	
<i>Dryopteris expansa</i> (spreading woodfern)	2001	7	13	54%	S2	G5	SC	
<i>Dryopteris filix-mas</i> (male fern)	2002	2	3	67%	S1	G5	SC	
<i>Dryopteris fragrans</i> var. <i>remotiuscula</i> (fragrant fern)	1997	16	27	59%	S3	G5T3T5	SC	
<i>Elatine triandra</i> (longstem water-wort)	1994	2	2	100%	S1	G5	SC	
<i>Eleocharis olivacea</i> (capitate spikerush)	1995	1	12	8%	S2	G5	SC	
<i>Eleocharis quinqueflora</i> (few-flower spikerush)	2006	2	18	11%	S2	G5	SC	
<i>Eleocharis robbinsii</i> (Robbins' spikerush)	2007	5	28	18%	S3	G4G5	SC	
<i>Epilobium palustre</i> (marsh willow-herb)	2007	11	37	30%	S3	G5	SC	
<i>Epilobium strictum</i> (downy willow-herb)	2006	5	22	23%	S2S3	G5?	SC	
<i>Equisetum palustre</i> (marsh horsetail)	1997	3	21	14%	S2	G5	SC	
<i>Equisetum variegatum</i> (variegated horsetail)	1995	4	47	9%	S3	G5	SC	
<i>Eriophorum alpinum</i> (alpine cotton-grass)	2007	10	25	40%	S2	G5	SC	
<i>Eriophorum chamissonis</i> (russet cotton-grass)	1996	2	6	33%	S2	G5	SC	
<i>Goodyera oblongifolia</i> (giant rattlesnake-plantain)	2005	2	4	50%	S1	G5?	SC	
<i>Juncus stygius</i> (moor rush)	1999	1	2	50%	S1	G5	END	
<i>Leucophysalis grandiflora</i> (large-flowered ground-cherry)	1997	1	3	33%	S1	G4?	SC	
<i>Littorella americana</i> (American shore-grass)	1982	1	6	17%	S2	G5	SC	
<i>Malaxis monophyllos</i> var. <i>brachypoda</i> (white adder's-mouth)	2007	11	48	23%	S3	G4Q	SC	
<i>Medeola virginiana</i> (Indian cucumber-root)	1997	1	42	2%	S3	G5	SC	
<i>Melica smithii</i> (Smith melic grass)	2007	8	8	100%	S1	G4	END	
<i>Moehringia macrophylla</i> (large-leaved sandwort)	1994	2	2	100%	S1	G4	END	
<i>Myriophyllum farwellii</i> (farwell's water-milfoil)	2004	38	60	63%	S3	G5	SC	
<i>Ophioglossum pusillum</i> (adder's-tongue)	2004	5	12	42%	S2	G5	SC	
<i>Oryzopsis canadensis</i> (Canada mountain-ricegrass)	1975	1	4	25%	S1	G5	SC	

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Appendix 12.C, continued.

Scientific name (common name)	Lastobs date	EOs ^a in in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
<i>Oxytropis campestris</i> var. <i>chartacea</i> (Fassett's locoweed)	2007	2	8	25%	S1S2	G5T1T2	END	LT
<i>Petasites sagittatus</i> (arrow-leaved sweet-coltsfoot)	2006	2	31	6%	S3	G5	THR	
<i>Phegopteris hexagonoptera</i> (broad beech fern)	2002	4	17	24%	S2	G5	SC	
<i>Platanthera dilatata</i> (leafy white orchis)	2006	13	31	42%	S3	G5	SC	
<i>Platanthera flava</i> var. <i>herbiola</i> (pale green orchid)	1997	4	20	20%	S2	G4T4Q	THR	
<i>Platanthera hookeri</i> (Hooker's orchid)	1997	3	20	15%	S2S3	G4	SC	
<i>Platanthera orbiculata</i> (large roundleaf orchid)	2001	18	78	23%	S3	G5	SC	
<i>Poa paludigena</i> (bog bluegrass)	2003	6	41	15%	S3	G3	THR	
<i>Polemonium occidentale</i> ssp. <i>lacustre</i> (western Jacob's ladder)	1999	2	2	100%	S1	G5?T1Q	END	
<i>Polystichum braunii</i> (Braun's holly-fern)	2002	39	39	100%	S3	G5	THR	
<i>Potamogeton diversifolius</i> (water-thread pondweed)	2003	16	29	55%	S2	G5	SC	
<i>Potamogeton hillii</i> (Hill's pondweed)	1998	2	2	100%	S1	G3	SC	
<i>Potamogeton vaseyi</i> (Vasey's pondweed)	2004	10	19	53%	S2	G4	SC	
<i>Pyrola minor</i> (lesser wintergreen)	1996	1	3	33%	S1	G5	END	
<i>Ranunculus gmelinii</i> (small yellow water crowfoot)	2004	3	16	19%	S2	G5	END	
<i>Rhynchospora fusca</i> (brown beakrush)	2003	4	21	19%	S2	G4G5	SC	
<i>Ribes hudsonianum</i> (northern black currant)	2007	48	76	63%	S3	G5	SC	
<i>Ribes oxycanthoides</i> (Canada gooseberry)	2000	5	7	71%	S2	G5	THR	
<i>Scirpus cespitosus</i> (tufted bulrush)	1992	1	20	5%	S2	G5	THR	
<i>Scirpus torreyi</i> (Torrey's bulrush)	2007	13	21	62%	S2	G5?	SC	
<i>Senecio congestus</i> (marsh ragwort)	2007	1	3	33%	S1	G5	SC	
<i>Streptopus amplexifolius</i> (white mandarin)	1998	6	29	21%	S3	G5	SC	
<i>Tiarella cordifolia</i> (heart-leaved foam-flower)	1994	2	3	67%	S1	G5	END	
<i>Triglochin maritima</i> (common bog arrow-grass)	2007	11	59	19%	S3	G5	SC	
<i>Utricularia geminiscapa</i> (hidden-fruited bladderwort)	2004	50	95	53%	S3	G4G5	SC	
<i>Utricularia purpurea</i> (purple bladderwort)	2007	29	55	53%	S3	G5	SC	
<i>Utricularia resupinata</i> (northeastern bladderwort)	1998	5	29	17%	S3	G4	SC	
<i>Vaccinium cespitosum</i> (dwarf huckleberry)	2001	4	6	67%	S2	G5	END	
<i>Vaccinium vitis-idaea</i> ssp. <i>minus</i> (mountain cranberry)	2008	5	7	71%	S1	G5T5	END	
<i>Valeriana sitchensis</i> ssp. <i>uliginosa</i> (marsh valerian)	1999	8	16	50%	S2	G4Q	THR	
<i>Viburnum edule</i> (squashberry)	2000	6	6	100%	S2	G5	END	

COMMUNITIES

Alder Thicket	2006	21	106	20%	S4	G4	NA
Bedrock Glade	2007	1	20	5%	S3	G2	NA
Black Spruce Swamp	2007	19	41	46%	S3?	G5	NA
Boreal Forest	1985	6	36	17%	S2	G3?	NA
Boreal Rich Fen	1997	4	18	22%	S2	G4G5	NA
Bracken Grassland	1986	1	6	17%	S2	G3	NA
Dry Cliff	1981	3	88	3%	S4	G4G5	NA
Emergent Marsh	2002	21	272	8%	S4	G4NA	
Emergent Marsh - Wild Rice	2000	3	15	20%	S3	G3G4	NA
Ephemeral Pond	2008	6	11	55%	SU	GNRQ	NA
Glaciere Talus	2000	4	6	67%	S2	G2G3	NA
Floodplain Forest	2003	5	182	3%	S3	G3?	NA
Forested Seep	2000	2	15	13%	S2	GNR	NA
Hardwood Swamp	2002	9	53	17%	S3	G4	NA
Inland Beach	1998	3	17	18%	S3	G4G5	NA
Lake—Deep, Hard, Drainage	1997	4	30	13%	S3	GNR	NA

Continued on next page

Appendix 12.C, continued.

Scientific name (common name)	Lastobs date	EOs ^a in in NCF	EOs in WI	Percent in NCF	State rank	Global rank	State status	Federal status
Lake—Deep, Soft, Drainage	1995	9	11	82%	S1	GNR	NA	
Lake—Deep, Soft, Seepage	2001	24	49	49%	S3	GNR	NA	
Lake—Deep, Very Soft, Seepage	2005	11	29	38%	S3	GNR	NA	
Lake—Hard Bog	1989	3	18	17%	S2	GNR	NA	
Lake—Meromictic	1985	4	4	100%	S1	GNR	NA	
Lake—Shallow, Hard, Drainage	2006	7	35	20%	SU	GNR	NA	
Lake—Shallow, Hard, Seepage	2006	3	52	6%	SU	GNR	NA	
Lake—Shallow, Soft, Drainage	2007	19	36	53%	S3	GNR	NA	
Lake—Shallow, Soft, Seepage	2007	35	87	40%	S4	GNR	NA	
Lake—Soft Bog	2005	28	52	54%	S4	GNR	NA	
Lake—Spring	1997	4	13	31%	S3	GNR	NA	
Lake—Unique	1981	1	7	14%	SU	GNR	NA	
Mesic Cedar Forest	2001	5	5	100%	S1	G3?	NA	
Moist Cliff	1998	8	176	5%	S4	GNR	NA	
Muskeg	2008	29	45	64%	S4	G4G5	NA	
Northern Dry Forest	1982	3	63	5%	S3	G3?	NA	
Northern Dry-mesic Forest	2008	45	284	16%	S3	G4	NA	
Northern Mesic Forest	2009	159	383	42%	S4	G4	NA	
Northern Sedge Meadow	2006	56	231	24%	S3	G4	NA	
Northern Wet Forest	2007	101	322	31%	S4	G4	NA	
Northern Wet-mesic Forest	2008	85	243	35%	S3S4	G3?	NA	
Open Bog	2007	60	173	35%	S4	G5	NA	
Patterned Peatland	2006	1	4	25%	S1	GNR	NA	
Poor Fen	2007	19	46	41%	S3	G3G4	NA	
Shrub-carr	1982	5	143	3%	S4	G5	NA	
Southern Dry-mesic Forest	2003	5	293	2%	S3	G4	NA	
Southern Hardwood Swamp	1982	1	30	3%	S2	G4?	NA	
Southern Sedge Meadow	2002	1	182	1%	S3	G4?	NA	
Spring Pond	2001	18	69	26%	S3	GNR	NA	
Springs and Spring Runs, Hard	2006	7	71	10%	S4	GNR	NA	
Springs and Spring Runs, Soft	1982	5	12	42%	SU	GNR	NA	
Stream—Fast, Hard, Cold	1995	15	98	15%	S4	GNR	NA	
Stream—Fast, Hard, Warm	1983	1	10	10%	SU	GNR	NA	
Stream—Fast, Soft, Cold	1981	1	15	7%	SU	GNR	NA	
Stream—Slow, Hard, Cold	2001	7	22	32%	SU	GNR	NA	
Stream—Slow, Hard, Warm	1980	2	20	10%	SU	GNR	NA	
Stream—Slow, Soft, Cold	1984	2	8	25%	SU	GNR	NA	
Stream—Slow, Soft, Warm	1982	6	14	43%	SU	GNR	NA	
Tamarack (Poor) Swamp	2006	9	33	27%	S3	G4	NA	
White Pine-Red Maple Swamp	2002	1	21	5%	S2	G3G4	NA	

OTHER ELEMENTS

Bird rookery	1998	4	54	7%	SU	G5	SC	
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^aAn element occurrence is an area of land and/or water in which a rare species or natural community is, or was, present. Element occurrences must meet strict criteria that is used by an international network of Heritage programs and coordinated by NatureServe.

^bNorthern long-eared bat was listed as Wisconsin Threatened on 6/01/2011 and as U.S. Threatened on 5/04/2015.

^cThe common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

^dThe American Ornithologist's Union lists these birds as Black-throated Blue Warbler (*Setophaga caerulescens*), Cerulean Warbler (*Setophaga cerulea*), Cape May Warbler (*Setophaga tigrina*), Louisiana Waterthrush (*Parkesia motacilla*), and Canada Warbler (*Cardellina canadensis*).

^eThe bullhead (sheepnose) mussel was listed as U.S. Endangered in 2012.

Status and ranking definitions continued on next page

Appendix 12.C, *continued*.

STATUS AND RANKING DEFINITIONS

U.S. Status—Current federal protection status designated by the Office of Endangered Species, U.S. Fish and Wildlife Service, indicating the biological status of a species in Wisconsin:

LE = listed endangered.

LT = listed threatened.

PE = proposed as endangered.

NEP = nonessential experimental population.

C = candidate for future listing.

CH = critical habitat.

State Status—Protection category designated by the Wisconsin DNR:

END = Endangered. Endangered species means any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the Wisconsin DNR to be in jeopardy on the basis of scientific evidence.

THR = Threatened species means any species of wild animals or wild plants that appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.

SC = Special Concern. Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proven. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Wisconsin DNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are as follows:

SC/P = fully protected;

SC/N = no laws regulating use, possession, or harvesting;

SC/H = take regulated by establishment of open closed seasons;

SC/FL = federally protected as endangered or threatened but not so designated by Wisconsin DNR;

SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factor(s) making it vulnerable to extinction throughout its range; typically 21-100 occurrences.

G4 = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery) and usually widespread. Typically > 100 occurrences.

G5 = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.

GH = Known only from historical occurrence throughout its range, with the expectation that it may be rediscovered.

GNR = Not ranked. Replaced G? rank and some GU ranks.

GU = Currently unrankable due to lack of data or substantially conflicting data on status or trends. Possibly in peril range-wide, but status is uncertain.

GX = Presumed to be extinct throughout its range (e.g., Passenger pigeon) with virtually no likelihood that it will be rediscovered.

Species with a questionable taxonomic assignment are given a "Q" after the global rank. Subspecies and varieties are given subranks composed of the letter "T" plus a number or letter. The definition of the second character of the subrank parallels that of the full global rank. (Examples: a rare subspecies of a rare species is ranked G1T1; a rare subspecies of a common species is ranked G5T1.)

State Element Ranks:

S1 = Critically imperiled in Wisconsin because of extreme rarity, typically 5 or fewer occurrences and/or very few (<1,000) remaining individuals or acres, or due to some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity, typically 6–20 occurrences and/or few (1,000– 3,000) remaining individuals or acres, or due to some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in Wisconsin, typically 21–100 occurrences and/or 3,000–10,000 individuals.

S4 = Apparently secure in Wisconsin, usually with > 100 occurrences and > 10,000 individuals.

S5 = Demonstrably secure in Wisconsin and essentially ineradicable under present conditions.

SNA = Accidental, nonnative, reported but unconfirmed, or falsely reported.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years and suspected to be still extant. Naturally, an element would become SH without such a 20-year delay if the only known occurrence were destroyed or if it had been extensively and unsuccessfully looked for.

SNR = Not Ranked; a state rank has not yet been assessed.

SU = Currently unrankable. Possibly in peril in the state, but status is uncertain due to lack of information or substantially conflicting data on status or trends.

SX = Apparently extirpated from the state.

State ranking of long-distance migrant animals:

Ranking long distance aerial migrant animals presents special problems relating to the fact that their nonbreeding status (rank) may be quite different from their breeding status, if any, in Wisconsin. In other words, the conservation needs of these taxa may vary between seasons. In order to present a less ambiguous picture of a migrant's status, it is necessary to specify whether the rank refers to the breeding (B) or nonbreeding (N) status of the taxon in question. (e.g., S2B, S5N).

Appendix 12.D. *Number of species with special designations documented within the North Central Forest Ecological Landscape, 2009.*

Listing status ^a	Taxa					Total fauna	Total flora	Total listed
	Mammals	Birds	Herptiles	Fishes	Invertebrates			
U.S. Endangered	1	0	0	0	0	1	0	1
U.S. Threatened	0	0	0	0	0	0	1	1
U.S. Candidate	0	0	0	0	1	1	0	1
Wisconsin Endangered	1	2	0	0	6	9	15	24
Wisconsin Threatened	0	4	2	5	4	15	15	30
Wisconsin Special Concern	7	19	4	7	50	87	65	152
Natural Heritage Inventory total	8	25	6	12	60	111	95	206


Note: Wisconsin-listed species always include federally listed species (although they may not have the same designation); therefore, federally listed species are not included in the total.

^aThe bullhead (sheepnose) mussel was listed as U.S. Endangered in 2012, and the northern long-eared bat was listed as Wisconsin Threatened species in 2011 and as U.S. Threatened in 2015; these species are not included in the numbers above.

Appendix 12.E. Species of Greatest Conservation Need (SGCN) Found in the North Central Forest Ecological Landscape.


These SGCN have a high or moderate probability of being found in this ecological landscape and use habitats that have the best chance for management here. Data are from the Wisconsin Wildlife Action Plan (WDNR 2005b) and Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3, "Supporting Materials." For more complete and/or detailed information, please see the Wisconsin Wildlife Action Plan. The Wildlife Action Plan is meant to be dynamic and will be periodically updated to reflect new information; the next update is planned for 2015.

Only SGCN highly or moderately (H = high association, M = moderate association) associated with specific community types or other habitat types and that have a high or moderate probability of occurring in the ecological landscape are included here (SGCN with a low affinity with a community type or other habitat type and with low probability of being associated with this ecological landscape were excluded). Only community types designated as "Major" or "Important" management opportunities for the ecological landscape are shown.

 Gray wolf. Photo by John & Karen Hollingsworth, courtesy U.S. Fish & Wildlife Service.	MAJOR																	IMPORTANT						
	Alder Thicket	Bedrock Glade	Coldwater streams	Coolwater streams	Emergent Marsh	Ephemeral Pond	Impoundments/Reservoirs	Inland lakes	Moist Cliff	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Open Bog	Submergent Marsh	Warmwater rivers	Warmwater streams	Boreal Forest	Boreal Rich Fen	Emergent Marsh – Wild Rice	Floodplain Forest	Northern Dry-mesic Forest	Shrub-carr
Species that are Significantly Associated with the North Central Forest Ecological Landscape																								
MAMMALS																								
American marten											H								H				H	
Gray wolf	H									M	H		H	H	M				H			M	H	M
Hoary bat	M		H	H	M	H		M		M	M	M	M	M	M	M	M	M	M	M		M	M	M
Northern flying squirrel										M	H		H	H					H			M	H	
Silver-haired bat	M		H	H	M	H		M		M	M	M	M	M	M	M	M	M	M	M		M	M	M
Water shrew	M		H	H				M		H	M		H	H				M	H			M		
Woodland jumping mouse						M				M	H		M	M					M			M		
BIRDS^a																								
American Bittern					H							H			H									
American Woodcock	H									M	M													H
Bald Eagle							H	H								M	H							
Black-backed Woodpecker													H						M					
Black-billed Cuckoo	H										M											M		H
Black-throated Blue Warbler											H												M	
Boreal Chickadee													H						M					
Canada Warbler	M									H	M		M	H					H	M			M	
Golden-winged Warbler	H									M	M		M		M								M	H
Least Flycatcher										M	H								M			M	M	
Lesser Scaup							M	M								H	M				M			
Northern Goshawk											H								M				M	
Northern Harrier												H			M									
Olive-sided Flycatcher													H	M	M				M					
Osprey							H	H									H							
Red Crossbill																							H	

Continued on next page

Appendix 12.E, continued.

 Red-shouldered Hawk. Photo courtesy U.S. Fish & Wildlife Service.	MAJOR																		IMPORTANT					
	Alder Thicket	Bedrock Glade	Coldwater streams	Coolwater streams	Emergent Marsh	Ephemeral Pond	Impoundments/Reservoirs	Inland lakes	Moist Cliff	Northern Hardwood Swamp	Northern Mesic Forest	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Open Bog	Submergent Marsh	Warmwater rivers	Warmwater streams	Boreal Forest	Boreal Rich Fen	Emergent Marsh – Wild Rice	Floodplain Forest	Northern Dry-mesic Forest	Shrub-carr
Red-shouldered Hawk						H				M														
Spruce Grouse													H		M				M					
Trumpeter Swan					H		M	M								H					H			
Veery	H									H	M		M						H			M	M	H
Whip-poor-will		M																					M	
Wood Thrush										M												M		
HERPTILES																								
Boreal chorus frog					H	H	H	H				H			H									
Four-toed salamander	H		M	M	H	H				M	H	M	M	H	H				M			H		H
Mink frog	M		M	H	H	M	H	H				H			H	H	H	H		M	M			M
Wood turtle	H		H	H		M				M	H	M	M	M		H	H	H				H		H
FISH																								
Gilt darter																	H	H						
Lake sturgeon							H	H									H							
Longear sunfish								M									M	M						
Species that are Moderately Associated with the North Central Forest Ecological Landscape																								
MAMMALS																								
Eastern red bat	M		H	H	M	H		M		M	M	M	M	M	M	M	M	M	M	M		M	M	M
Moose	H				H		M	H		H	M	M	M	H	M	H	M	M	H			M		H
Northern long-eared bat	M		H	H	M	H		M		M	M	M			M	M	M	M		M		M	M	M
BIRDS																								
Black Tern					H		M	M			M					M					M			
Bobolink												H			M									
Canvasback							M	M								H	H				M			
Cerulean Warbler																						H		
Connecticut Warbler													M		M					M				
Rusty Blackbird	M				M	M									M							H		M
Sharp-tailed Grouse											M													
Solitary Sandpiper			M	M	H	H									M			M				H		
HERTILES																								
Mudpuppy			M				H	H									H							
Pickerel frog	M		H	H	H	H	H	M			M	H	M	M	M	H	H	H				M		M
FISH																								
Greater redhorse							M	M									M	H						

^aThe common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 12.F. Natural communities^a for which there are management opportunities in the North Central Forest Ecological Landscape.

Major opportunity ^b	Important opportunity ^c	Present ^d
Northern Mesic Forest	Boreal Forest	Northern Dry Forest
Northern Wet-mesic Forest	Northern Dry-mesic Forest	
Northern Wet Forest		Surrogate Grasslands
Northern Hardwood Swamp	Floodplain Forest	
		Inland Beach
Alder Thicket	Shrub-carr	
		Bracken Grassland
Northern Sedge Meadow	Boreal Rich Fen	
	Emergent Marsh - Wild Rice	
Open Bog (includes Muskeg, Poor Fen)		
Emergent Marsh		
Floating-leaved Marsh		
Submergent Marsh		
Ephemeral Pond		
Bedrock Glade		
Dry Cliff (Curtis's Exposed Cliff)		
Moist Cliff (Curtis's Shaded Cliff)		
Coldwater Stream		
Coolwater Stream		
Impoundment/Reservoir ^c		
Inland Lake		
Warmwater River		
Warmwater Stream		

^aSee Chapter 7, "Natural Communities, Aquatic Features, and Selected Habitats of Wisconsin," in Part 1 for definitions of natural community types. Also see Appendix E, "Opportunities for Sustaining Natural Communities in Each Ecological Landscape," in Part 3 ("Supporting Materials") for an explanation on how the information in this table can be used.

^bMajor opportunity – Relatively abundant, represented by multiple significant occurrences, or ecological landscape is appropriate for major restoration activities.

^cImportant opportunity – Less abundant but represented by one to several significant occurrences or type is restricted to one or a few ecological landscapes.

^dPresent – Uncommon or rare, with no good occurrences documented. Better opportunities are known to exist in other ecological landscapes, or opportunities have not been adequately evaluated.

Appendix 12.G. Public conservation lands in the North Central Forest Ecological Landscape, 2005.

Property name	Size (acres) ^a
STATE	
Benson Creek State Fishery Area	300
Beverly Lake State Fishery Area	275
Bill Cross State Wildlife Area ^b	1,170
Bog Brook State Wildlife Area	265
Brunet Island State Park	1,070
Chief River State Wildlife Area	1,190
Chippewa Flowage	13,920
Chippewa Moraine State Recreation Area ^b	2,760
Copper Falls State Park ^b	2,015
Dunn Lake State Natural Area	560
Eddy Creek State Fishery Area	280
Flambeau River State Forest	90,135
Grindstone Creek State Fishery Area	410
Hay Creek-Hoffman Lake State Wildlife Area ^b	12,605
Kimberly Clark State Wildlife Area	8,570
Kissick Swamp State Wildlife Area	930
Lake Evelyn State Natural Area	220
Little Rice State Wildlife Area	2,860
Moose Lake State Natural Area	2,060
New Wood State Wildlife Area	1,640
Niebauer Springs Fishery Area	200
Northern Highland-American Legion State Forest ^b	5,890
Pershing State Wildlife Area	7,440
Peters Marsh State Wildlife Area	1,740
Pine-Popple Wild Rivers ^b	4,100
Potato Creek State Wildlife Area	940
Prairie River State Fishery Area ^b	450
Silvernail State Wildlife Area	1,050
Spread Eagle Barrens State Natural Area ^b	315
Spring Creek State Wildlife Area	920
Tom Lawin State Wildlife Area ^b	515
Totagatic Highlands Hemlock State Natural Area	160
Totagatic Lake State Wildlife Area	980
Totagatic State Wildlife Area	2,660
Turtle Flambeau Scenic Waters Area ^b	9,380
Underwood State Wildlife Area	1,630
Upper Wolf River State Fishery Area ^b	5,930
Washington Creek State Wildlife Area	525
Weirgor Springs State Wildlife Area	1,960
White River State Fishery Area ^b	340
Willow Flowage Scenic Waters Area ^b	8,790
Miscellaneous Lands ^c	15,965
FEDERAL	
Chequamegon-Nicolet National Forests ^b	1,186,860
St. Croix National Scenic Riverway	3,390
COUNTY FOREST^d	
Ashland County Forest	32,830
Barron County Forest ^b	5,210
Bayfield County Forest ^b	28,230
Chippewa County Forest ^b	31,410
Douglas County Forest ^b	6,610
Florence County Forest ^b	15,260

Continued on next page

Appendix 12.G, continued.

Property name	Size (acres) ^a
Forest County Forest ^b	10,690
Iron County Forest ^b	150,370
Langlade County Forest ^b	86,500
Lincoln County Forest ^b	90,160
Marinette County Forest ^b	36,450
Oneida County Forest ^b	56,850
Price County Forest	88,010
Rusk County Forest ^b	86,920
Sawyer County Forest ^b	110,630
Taylor County Forest ^b	13,330
Vilas County Forest ^b	4,240
Washburn County Forest ^b	74,940
TOTAL	2,335,195

Source: *Wisconsin Land Legacy Report* (WDNR 2006c).

^aActual acres owned in this ecological landscape.

^bThis property also falls within adjacent ecological landscape(s).

^cIncludes public access sites, fish hatcheries, fire towers, streambank and nonpoint easements, lands acquired under statewide wildlife, fishery, forestry, and natural area programs, Board of Commissioners of Public Lands holdings, small properties under 100 acres, and properties with fewer than 100 acres within this ecological landscape.

^dLocations and sizes of county-owned parcels enrolled in the Forest Crop Law program are presented here. Information on locations and sizes of other county and local parks in this ecological landscape is not readily available and is not included here, except for some very large properties.

Appendix 12.H. Land Legacy places in the North Central Forest Ecological Landscape and their ecological and recreational significance.

The *Wisconsin Land Legacy Report* (WDNR 2006c) identified 42 places in the North Central Forest Ecological Landscape that merit conservation action, based upon a combination of ecological significance and recreational potential. The Blue Hills feature extensive forests and Felsenmeers, which support several rare species in a cool microclimate, the Goodman Forest guards the headwaters of the Pike and Peshtigo rivers, and the Pershing Wildlife Area offers potential to expand Sharp-tailed Grouse habitat. From an ecosystem management perspective, some of the best opportunities or higher priorities may be the Border Lakes Region and the Haugen-Birchwood Lakeland, with superb aquatic diversity; the Jump, Namekagon, Prairie, Upper Chippewa, and Upper Flambeau rivers, featuring exceptional riverine aquatic diversity; the hemlock-hardwoods of Laona and Moose Creek; and the Pipestone Hills area with a diversity of hardwood forest birds. These areas have high conservation significance and have either substantial remaining protection opportunities or are large in size.

In this large ecological landscape, the *Wisconsin Land Legacy Report* notes numerous other areas worthy of further consideration for conservation action, including Bootjack Bog, the Couderay River, Mosquito Brook, and the Springstead Area Woods.

Map Code	Place name	Size	Protection initiated	Protection remaining	Conservation significance ^a	Recreation potential ^b
BD	Bad River	Large	Substantial	Limited	xxxx	xx
BR	Black River	Large	Limited	Substantial	xxx	xxx
BI	Blue Hills	Large	Substantial	Limited	xxxx	xxxx
BL	Border Lakes Region	Large	Moderate	Moderate	xxxxx	xx
CN	Chequamegon-Nicolet Nat'l Forests	Large	Substantial	Limited	xxxxx	xxxxx
CH	Chippewa Flowage	Large	Substantial	Limited	xxx	xxxxx
CL	Chippewa Glacial Lakes	Large	Substantial	Moderate	xxxx	xxxxx
DK	Deerskin River	Medium	Moderate	Limited	xxx	x
EC	East and West Branches of the Eau Claire River	Medium	Moderate	Moderate	xx	xxx
ER	Eau Claire River	Small	Limited	Moderate	xxx	xx
FR	Flambeau River State Forest	Large	Substantial	Limited	xxxx	xxxxx
GF	Gile Flowage	Small	Limited	Moderate	xx	xxx
GM	Goodman Forest	Medium	Limited	Substantial	xxx	xx
HH	Harrison Hills	Medium	Substantial	Limited	xxx	xxx
HB	Haugen-Birchwood Lakeland	Medium	Moderate	Moderate	xxxx	xxxx
JR	Jump River	Large	Limited	Substantial	xxxx	xxx
LA	Langlade Moraine	Medium	Moderate	Substantial	xx	xxx
LH	Laona Hemlock Hardwoods	Small	Limited	Substantial	xxxx	xx
LO	Lost Lake Bog	Small	Limited	Moderate	xxx	x
MR	Menominee River	Large	Substantial	Moderate	xxxx	xxx
MF	Monico Forest	Medium	Limited	Substantial	x	xx
MT	Montreal River	Medium	Limited	Substantial	xx	xxx
MO	Moose Creek Hemlock Woods	Small	Limited	Substantial	xxxxx	xx
NR	Namekagon River	Large	Moderate	Moderate	xxxxx	xxxx
NF	North Fork of the Chief River	Small	Moderate	Limited	x	xxx
PG	Penokee-Gogebic Range	Large	Substantial	Moderate	xxxxx	xxx
PA	Pershing Area	Medium	Substantial	Limited	xx	xx
PE	Peshtigo River	Large	Substantial	Moderate	xxx	xxxxx
PP	Pine-Popple River	Large	Substantial	Moderate	xxxx	xxx
PI	Pipestone Hills	Medium	Limited	Substantial	xxxx	xxx
PR	Prairie River	Medium	Moderate	Substantial	xxxx	xxx
SO	Somo River	Medium	Moderate	Moderate	x	xx
TP	Thornapple - Brunet River Woods	Large	Moderate	Moderate	xxx	xxx
TH	Timm's Hill	Medium	Substantial	Moderate	xxx	xxx
TF	Turtle-Flambeau Flowage	Large	Substantial	Limited	xxxx	xxxxx
UC	Upper Chippewa River	Large	Limited	Substantial	xxxxx	xxxx
UF	Upper Forks of the Flambeau River	Large	Limited	Substantial	xxxxx	xxxx

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Appendix 12.H, continued.

Code	Place name	Size	Protection initiated	Protection remaining	Conservation significance ^a	Recreation potential ^b
UW	Upper Wisconsin River	Large	Moderate	Moderate	xxx	xxx
UP	Upper Wolf River	Large	Substantial	Limited	xxxxx	xxxxx
WC	Weyerhauser Cedar Swamp	Small	Limited	Moderate	xx	x
WF	Willow Flowage	Medium	Substantial	Limited	xx	xxxxx
YC	Yellow (Chippewa) River	Medium	Limited	Moderate	xxx	xx

^a**Conservation significance.** See the *Wisconsin Land Legacy Report* (WDNR 2006c), p. 43, for detailed discussion.

- xxxxx Possesses outstanding ecological qualities, is large enough to meet the needs of critical components, and/or harbors globally or continentally significant resources. Restoration, if needed, has a high likelihood of success.
- xxxx Possesses excellent ecological qualities, is large enough to meet the needs of most critical components, and/or harbors continentally or Great Lakes regionally significant resources. Restoration has a high likelihood of success.
- xxx Possesses very good ecological qualities, is large enough to meet the needs of some critical components, and/or harbors statewide significant resources. Restoration will typically be important and has a good likelihood of success.
- xx Possesses good ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors statewide or ecological landscape significant resources. Restoration is likely needed and has a good chance of success.
- x Possesses good to average ecological qualities, may be large enough to meet the needs of some critical components, and/or harbors ecological landscape significant resources. Restoration is needed and has a reasonable chance of success.

^b**Recreation potential.** See the *Wisconsin Land Legacy Report*, p. 43, for detailed discussion.

- xxxxx Outstanding recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet many current and future recreation needs, is large enough to accommodate incompatible activities, could link important recreation areas, and/or is close to state's largest population centers.
- xxxx Excellent recreation potential, could offer a wide variety of land and water-based recreation opportunities, could meet several current and future recreation needs, is large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to large population centers.
- xxx Very good recreation potential, could offer a variety of land and/or water-based recreation opportunities, could meet some current and future recreation needs, may be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized to large population centers.
- xx Good to moderate recreation potential, could offer some land and/or water-based recreation opportunities, might meet some current and future recreation needs, may not be large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to mid-sized population centers.
- x Limited recreation potential, could offer a few land and/or water-based recreation opportunities, might meet some current and future recreation needs, is not likely large enough to accommodate some incompatible activities, could link important recreation areas, and/or is close to small population centers.

Appendix 12.1. Importance of economic sectors (based on the number of jobs) within the North Central Forest (NCF) counties compared to the rest of the state.

Industry	CLMC	CSH	CSP	FT	NCF	NES	NH	NLMC	NWL	NWS	SEGP	SLMC	SWS	SCP	WCR	WP
Agriculture, Fishing & Hunting	0.87	2.14	2.41	2.15	2.15	1.90	0.50	2.71	0.43	1.29	0.76	0.10	4.46	0.87	2.36	2.30
Forest Products & Processing	1.64	0.98	1.83	2.40	3.43	2.20	1.33	1.74	0.41	1.07	0.65	0.32	0.45	1.44	0.96	0.69
Mining	1.08	1.64	0.79	0.79	2.69	3.55	0.91	2.16	0.16	0.34	1.47	0.19	0.62	0.08	0.77	1.21
Utilities	2.44	1.08	0.81	0.39	0.61	0.45	0.58	0.41	1.96	1.76	0.67	0.65	0.81	1.83	1.19	0.51
Construction	1.12	1.02	0.89	0.96	1.14	0.92	2.38	1.08	1.07	1.14	1.08	0.67	0.98	1.13	1.03	1.11
Manufacturing (non-wood)	1.23	1.02	0.74	0.98	0.90	1.37	0.21	1.15	0.49	0.59	1.19	0.87	0.78	0.46	0.77	0.99
Wholesale Trade	0.99	0.63	0.61	0.95	0.62	0.53	0.47	0.60	1.15	0.72	1.16	0.98	0.89	0.76	0.83	0.53
Retail Trade	1.01	1.00	0.99	1.11	1.11	1.00	1.66	1.03	1.30	1.19	1.02	0.80	1.69	1.11	1.11	1.13
Tourism-related	0.99	1.12	0.97	0.86	0.99	1.05	1.51	1.28	1.34	1.41	0.94	1.02	0.78	1.33	1.08	1.12
Transportation & Warehousing	0.95	1.32	2.13	1.40	1.19	1.15	0.80	0.89	3.25	2.15	0.82	0.83	0.74	2.12	1.39	0.99
Information	0.76	0.49	0.69	0.74	0.58	0.68	0.80	0.70	0.38	0.49	1.22	1.11	1.09	0.64	0.62	0.57
Finance & Insurance	1.22	1.31	0.89	0.96	0.56	0.46	0.43	0.48	0.47	0.46	1.04	1.18	0.65	0.45	0.70	0.55
Real Estate, Rental & Leasing	0.84	0.73	0.59	0.60	0.52	0.34	1.37	0.95	0.42	0.50	1.17	1.14	0.47	0.46	0.87	0.66
Pro, Science & Tech Services	0.85	0.53	0.46	0.55	0.41	0.36	0.43	0.45	0.51	0.47	1.04	1.51	0.49	0.47	0.63	0.81
Management	0.80	0.26	0.63	0.54	0.37	0.21	0.17	0.24	0.65	0.47	0.94	1.62	0.08	0.64	0.87	0.45
Admin, Support, Waste, & Remediation	0.99	0.42	0.43	0.46	0.34	0.23	0.61	0.34	0.61	0.43	0.92	1.64	0.58	0.51	0.70	0.63
Private Education	0.86	0.68	0.39	0.42	0.86	0.72	0.87	0.55	0.08	0.12	0.80	1.94	0.09	1.53	0.68	0.55
Health Care & Social Services	0.85	0.88	1.27	1.04	0.82	0.90	0.87	0.84	0.96	0.91	0.83	1.32	0.84	0.99	1.09	0.94
Other Services	1.08	1.32	1.10	1.05	1.10	1.13	1.25	1.19	1.36	1.09	1.06	0.84	1.14	1.13	0.91	1.29
Government	0.78	1.09	1.11	1.03	1.26	1.36	1.08	1.03	1.36	1.54	1.04	0.89	1.15	1.50	1.14	1.21

Source: Based on an economic base analysis using location quotients (Quintero 2007). Definitions of economic sectors can be found at the U.S. Census Bureau's North American Industry Classification System web page (USCB 2013).

Appendix 12.J. Scientific names of species mentioned in the text.

Common name	Scientific name
Algae-like pondweed	<i>Potamogeton confervoides</i>
American basswood	<i>Tilia americana</i>
American beaver	<i>Castor canadensis</i>
American beech	<i>Fagus grandifolia</i>
American Bittern ^a	<i>Botaurus lentiginosus</i>
American black bear	<i>Ursus americanus</i>
American bullfrog	<i>Lithobates catesbeianus</i>
American elm	<i>Ulmus americana</i>
American marten	<i>Martes americana</i>
American Redstart	<i>Setophaga ruticilla</i>
American Woodcock	<i>Scolopax minor</i>
Annosum root rot fungus	<i>Heterobasidion annosum</i>
Ashes	<i>Fraxinus</i> spp.
Aspen heart rot fungus	<i>Phellinus tremulae</i>
Aspen hypoxylon canker fungus	<i>Hypoxylon mammatum</i>
Aspens	<i>Populus</i> spp.
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Balsam fir	<i>Abies balsamea</i>
Baltimore Oriole	<i>Icterus galbula</i>
Barn Owl	<i>Tyto alba</i>
Big-tooth aspen	<i>Populus grandidentata</i>
Black ash	<i>Fraxinus nigra</i>
Black bulrush	<i>Scirpus atrovirens</i>
Black crappie	<i>Pomoxis nigromaculatus</i>
Black locust	<i>Robinia pseudoacacia</i>
Black spruce	<i>Picea mariana</i>
Black Tern	<i>Chlidonias niger</i>
Black walnut	<i>Juglans nigra</i>
Black-backed Woodpecker	<i>Picoides arcticus</i>
Black-throated Blue Warbler	<i>Setophaga caerulescens</i> , listed as <i>Dendroica caerulescens</i> on the Wisconsin Natural Heritage Working List
Black-throated Green Warbler	<i>Setophaga virens</i>
Blackburnian Warbler	<i>Setophaga fusca</i>
Blanding's turtle	<i>Emydoidea blandingii</i>
Blue-headed Vireo	<i>Vireo solitarius</i>
Blue-spotted salamander	<i>Ambystoma laterale</i>
Bluegill	<i>Lepomis macrochirus</i>
Bobcat	<i>Lynx rufus</i>
Bog birch	<i>Betula pumila</i>
Bog bluegrass	<i>Poa paludigena</i>
Bog laurel	<i>Kalmia polifolia</i>
Bog rosemary	<i>Andromeda glaucophylla</i>
Boreal Chickadee	<i>Poecile hudsonicus</i>
Braun's holly fern	<i>Polystichum braunii</i>
Bronze birch borer	<i>Agrilus anxius</i>
Brook trout	<i>Salvelinus fontinalis</i>
Brown Creeper	<i>Certhia americana</i>
Brown Thrasher	<i>Toxostoma rufum</i>
Brown trout	<i>Salmo trutta</i>
Bullhead (sheepnose)	<i>Plethobasus cyphus</i>
Butternut	<i>Juglans cinerea</i>
Butternut canker fungus	<i>Sirococcus clavigignenti-juglandacearum</i>
Caddisfly	<i>Hydropsyche bidens</i>
Calypso orchid	<i>Calypso bulbosa</i>
Canada thistle	<i>Cirsium arvense</i>

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Appendix 12.J, continued.

Common name	Scientific name
Canada yew	<i>Taxus canadensis</i>
Cape May Warbler	<i>Setophaga tigrina</i> , listed as <i>Dendroica tigrina</i> on the Wisconsin Natural Heritage Working List
Cerulean Warbler	<i>Setophaga cerulea</i> , listed as <i>Dendroica cerulea</i> on the Wisconsin Natural Heritage Working List
Cherrystone drop terrestrial snail	<i>Hendersonia occulta</i>
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>
Chokeberry	<i>Aronia melanocarpa</i>
Common buckthorn	<i>Rhamnus cathartica</i>
Common Loon	<i>Gavia immer</i>
Common reed	<i>Phragmites australis</i>
Common tansy	<i>Tanacetum vulgare</i>
Common winterberry	<i>Ilex verticillata</i>
Connecticut Warbler	<i>Oporornis agilis</i>
Cougar	<i>Puma concolor</i>
Coyote	<i>Canis latrans</i>
Curly pondweed	<i>Potamogeton crispus</i>
Cut-leaved toothwort	<i>Cardamine concatenata</i>
Dame's rocket	<i>Hesperis matronalis</i>
Dogwoods	<i>Cornus</i> spp.
Dutch elm disease fungus	<i>Ophiostoma ulmi</i>
Dwarf ginseng	<i>Panax trifolius</i>
Eastern dwarf mistletoe	<i>Arceuthobium pusillum</i>
Eastern elliptio	<i>Elliptio complanata</i>
Eastern hemlock	<i>Tsuga canadensis</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Eastern white pine	<i>Pinus strobus</i>
Eastern Wood-Pewee	<i>Contopus virens</i>
Elk	<i>Cervus canadensis</i>
Ellipse	<i>Venustaconcha ellipsiformis</i>
Elms	<i>Ulmus</i> spp.
Emerald ash borer	<i>Agrilus planipennis</i>
Eurasian honeysuckles	<i>Lonicera morrowii</i> , <i>L. tatarica</i> , and <i>L. x bella</i>
Eurasian water-milfoil	<i>Myriophyllum spicatum</i>
European swamp thistle	<i>Cirsium palustre</i>
Evening Grosbeak	<i>Coccothraustes vespertinus</i>
Extra-striped snaketail	<i>Ophiogomphus anomalus</i>
Fairy slipper	<i>Calypso bulbosa</i>
Fassett's locoweed	<i>Oxytropis campestris</i> var. <i>chartacea</i>
Fathead minnow	<i>Pimephales promelas</i>
Firs	<i>Abies</i> spp.
Fisher	<i>Martes pennanti</i>
Foamflower	<i>Tiarella cordifolia</i>
Forest tent caterpillar	<i>Malacosoma disstria</i>
Four-toed salamander	<i>Hemidactylium scutatum</i>
Freija fritillary	<i>Boloria freija</i>
Frigga fritillary	<i>Boloria frigga</i>
Garlic mustard	<i>Alliaria petiolata</i>
Gilt darter	<i>Percina evides</i>
Glossy buckthorn	<i>Rhamnus frangula</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Golden-winged Warbler	<i>Vermivora chrysoptera</i>
Gray fox	<i>Urocyon cinereoargenteus</i>
Gray Jay	<i>Perisoreus canadensis</i>
Gray wolf	<i>Canis lupus</i>

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Appendix 12.J, continued.

Common name	Scientific name
Great Crested Flycatcher.....	<i>Myiarchus crinitus</i>
Greater redhorse.....	<i>Moxostoma valenciennesi</i>
Green frog.....	<i>Rana clamitans</i>
Gypsy moth.....	<i>Lymantria dispar</i>
Hermit Thrush.....	<i>Catharus guttatus</i>
Hill's pondweed.....	<i>Potamogeton hillii</i>
Indigo Bunting.....	<i>Passerina cyanea</i>
Jack pine.....	<i>Pinus banksiana</i>
Jack pine budworm.....	<i>Choristoneura pinus</i>
Japanese barberry.....	<i>Berberis thunbergii</i>
Japanese knotweed.....	<i>Polygonum cuspidatum</i>
Lake sturgeon.....	<i>Acipenser fulvescens</i>
Large-flowered bellwort.....	<i>Uvularia grandiflora</i>
Largemouth bass.....	<i>Micropterus salmoides</i>
Laurentian bladder fern.....	<i>Cystopteris laurentiana</i>
Le Conte's Sparrow.....	<i>Ammodramus leconteii</i>
Leafy spurge.....	<i>Euphorbia esula</i>
Leatherleaf.....	<i>Chamaedaphne calyculata</i>
Lilacs.....	<i>Syringa</i> spp.
Little goblin moonwort fern.....	<i>Botrychium mormo</i>
Loggerhead Shrike.....	<i>Lanius ludovicianus</i>
Longear sunfish.....	<i>Lepomis megalotis</i>
Mallard.....	<i>Anas platyrhynchos</i>
Mink frog.....	<i>Rana septentrionalis</i>
Moose.....	<i>Alces americanus</i>
Mountain holly.....	<i>Ilex mucronata</i>
Mourning Warbler.....	<i>Geothlypis philadelphia</i>
Mudpuppy.....	<i>Necturus maculosus</i>
Muskellunge.....	<i>Esox masquinongy</i>
Nonnative earthworms.....	family Lumbricidae
North American river otter.....	<i>Lontra canadensis</i>
Northern blue butterfly.....	<i>Lycaeides idas</i>
Northern Goshawk.....	<i>Accipiter gentilis</i>
Northern Harrier.....	<i>Circus cyaneus</i>
Northern Parula.....	<i>Setophaga americana</i>
Northern pike.....	<i>Esox lucius</i>
Northern red oak.....	<i>Quercus rubra</i>
Northern Saw-whet Owl.....	<i>Aegolius acadicus</i>
Northern Waterthrush.....	<i>Parkesia noveboracensis</i>
Northern white-cedar.....	<i>Thuja occidentalis</i>
Oak wilt fungus.....	<i>Ceratocystis fagacearum</i>
Oaks.....	<i>Quercus</i> spp.
Osprey.....	<i>Pandion haliaetus</i>
Ovenbird.....	<i>Seiurus aurocapilla</i>
Ozark minnow.....	<i>Notropis nubilus</i>
Pickerel frog.....	<i>Lithobates palustris</i>
Pileated Woodpecker.....	<i>Dryocopus pileatus</i>
Pine.....	<i>Pinus</i> spp.
Pine blight fungus.....	<i>Diplodia pinea</i>
Pine sawfly.....	<i>Neodiprion</i> spp., <i>Diprion</i> spp.
Pine siskin.....	<i>Spinus pinus</i>
Privets.....	<i>Ligustrum</i> spp.
Pugnose minnow.....	<i>Opsopoeodus emiliae</i>
Pugnose shiner.....	<i>Notropis anogenus</i>
Pumpkinseed.....	<i>Lepomis gibbosus</i>

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Appendix 12.J, continued.

Common name	Scientific name
Purple Finch	<i>Carpodacus purpureus</i>
Purple loosestrife	<i>Lythrum salicaria</i>
Purple wartback	<i>Cyclonaias tuberculata</i>
Pygmy snaketail	<i>Ophiogomphus howei</i>
Quaking aspen	<i>Populus tremuloides</i>
Ram's-head lady's-slipper	<i>Cypripedium arietinum</i>
Red Crossbill	<i>Loxia curvirostra</i>
Red fox	<i>Vulpes vulpes</i>
Red maple	<i>Acer rubrum</i>
Red pine	<i>Pinus resinosa</i>
Red pine pocket mortality fungal species	<i>Leptographium procerum</i> and <i>L. terrebrantis</i>
Red-backed salamander	<i>Plethodon cinereus</i>
Red-breasted Nuthatch	<i>Sitta canadensis</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Redside dace	<i>Clinostomus elongatus</i>
Reed canary grass	<i>Phalaris arundinacea</i>
Riffle beetle	<i>Stenelmis bicarinata</i>
Ring-necked Duck	<i>Aythya collaris</i>
Rosy twisted-stalk	<i>Streptopus roseus</i>
Ruffed Grouse	<i>Bonasa umbellus</i>
Rugulose grape-fern	<i>Botrychium rugulosum</i>
Rusty crayfish	<i>Orconectes rusticus</i>
Saint croix snaketail	<i>Ophiogomphus susbehcha</i>
Salamander mussel	<i>Simpsonaias ambigua</i>
Sand snaketail	<i>Ophiogomphus smithi</i>
Sandhill Crane	<i>Grus canadensis</i>
Sedge Wren	<i>Cistothorus platensis</i>
Showy mountain ash	<i>Sorbus decora</i>
Sioux snaketail	<i>Ophiogomphus smithi</i>
Smallmouth bass	<i>Micropterus dolomieu</i>
Smith's melic grass	<i>Melica smithii</i>
Snowshoe hare	<i>Lepus americanus</i>
Sphagnum mosses	<i>Sphagnum</i> spp.
Spotted knapweed	<i>Centaurea biebersteinii</i>
Spotted salamander	<i>Ambystoma maculatum</i>
Spring-beauty	<i>Claytonia virginica</i>
Spruce budworm	<i>Choristoneura fumiferana</i>
Spruce Grouse	<i>Falcipennis canadensis</i>
Spruces	<i>Picea</i> spp.
Sugar maple	<i>Acer saccharum</i>
Swainson's Thrush	<i>Catharus ustulatus</i>
Tamarack	<i>Larix laricina</i>
Trumpeter swan	<i>Cygnus buccinator</i>
Tussock sedge	<i>Carex stricta</i>
Two-lined chestnut borer	<i>Agrilus bilineatus</i>
Veery	<i>Catharus fuscescens</i>
Virginia waterleaf	<i>Hydrophyllum virginianum</i>
Walleye	<i>Sander vitreus</i>
Warpaint emerald	<i>Somatochlora incurvata</i>
Water shrew	<i>Sorex palustris</i>
Watercress	<i>Nasturtium officinale</i>
Weasels	<i>Mustela</i> spp.
Western Jacob's ladder	<i>Polemonium occidentale</i> var. <i>lacustre</i>
White ash	<i>Fraxinus americana</i>

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Appendix 12.J, continued.

Common name	Scientific name
White birch	<i>Betula papyrifera</i>
White pine blister rust fungus	<i>Cronartium ribicola</i>
White spruce	<i>Picea glauca</i>
White sucker	<i>Catostomus commersonii</i>
White-tailed deer	<i>Odocoileus virginianus</i>
White-winged Crossbill	<i>Loxia leucoptera</i>
Wild leek	<i>Allium tricoccum</i>
Wild parsnip	<i>Pastinaca sativa</i>
Wild rice	<i>Zizania</i> spp.
Willows	<i>Salix</i> spp.
Winter Wren	<i>Troglodytes hiemalis</i>
Wood Duck	<i>Aix sponsa</i>
Wood turtle	<i>Glyptemys insculpta</i>
Wool-grass	<i>Scirpus cyperinus</i>
Yellow birch	<i>Betula alleghaniensis</i>
Yellow perch	<i>Perca flavescens</i>
Yellow Rail	<i>Coturnicops noveboracensis</i>
Yellow Warbler	<i>Setophaga petechia</i>
Yellow-rumped Warbler	<i>Setophaga coronata</i>

^aThe common names of birds are capitalized in accordance with the checklist of the American Ornithologists Union.

Appendix 12.K. *Maps of important physical, ecological, and aquatic features within the North Central Forest Ecological Landscape.*

- Vegetation of the North Central Forest Ecological Landscape in the Mid-1800s
- Land Cover of the North Central Forest Ecological Landscape in the Mid-1800s
- Landtype Associations of the North Central Forest Ecological Landscape
- Public Land Ownership, Easements, and Private land enrolled in the Forest Tax Programs in the North Central Forest Ecological Landscape
- Ecologically Significant Places of the North Central Forest Ecological Landscape
- Exceptional and Outstanding Resource Waters and 303(d) Degraded Waters of the North Central Forest Ecological Landscape
- Dams of the North Central Forest Ecological Landscape
- WISCLAND Land Cover (1992) of the North Central Forest Ecological Landscape
- Soil Regions of the North Central Forest Ecological Landscape
- Relative Tree Density of the North Central Forest Ecological Landscape in the Mid-1800s
- Population Density, Cities, and Transportation of the North Central Forest Ecological Landscape

Note: Go to <http://dnr.wi.gov/topic/landscapes/index.asp?mode=detail&Landscape=11> and click the “maps” tab.

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